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HEATING AND VENTILATING

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AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION

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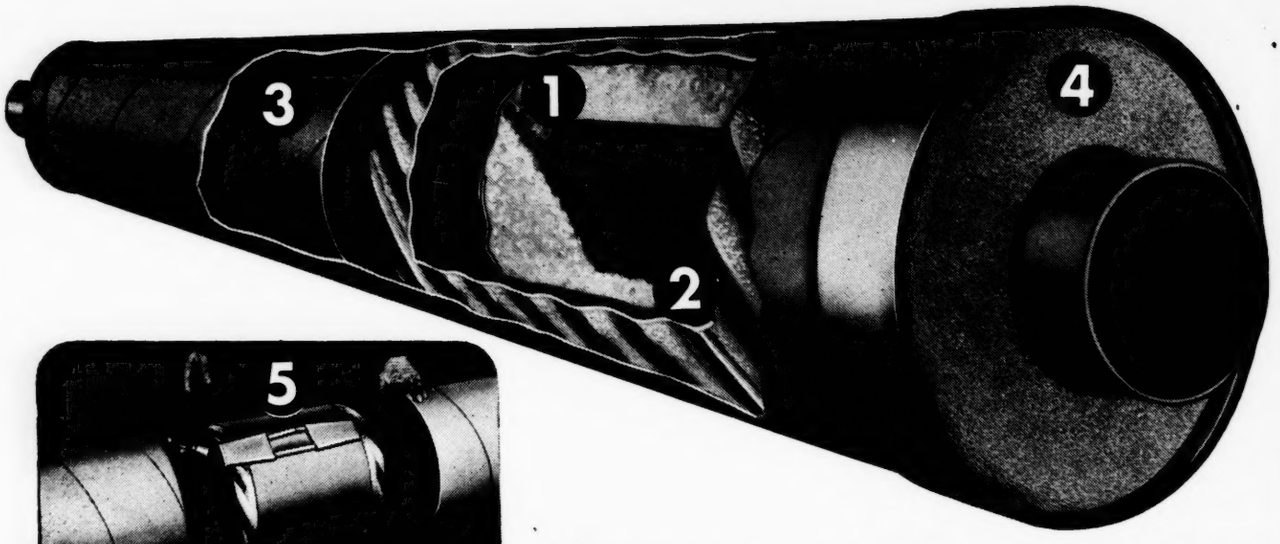
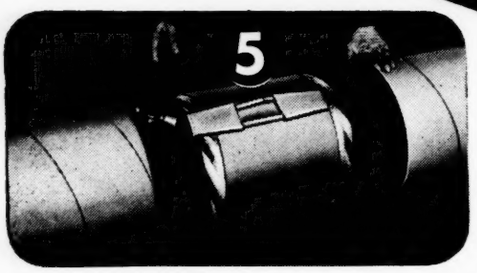
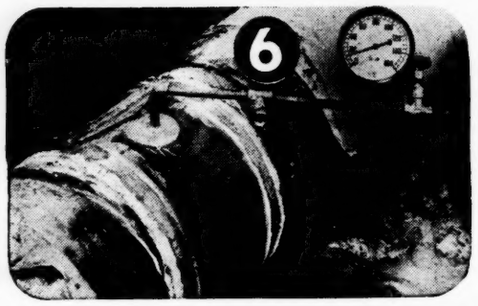
RIC-WIL







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VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, AIR SANITATION, PIPING, HEATING AND VENTILATION

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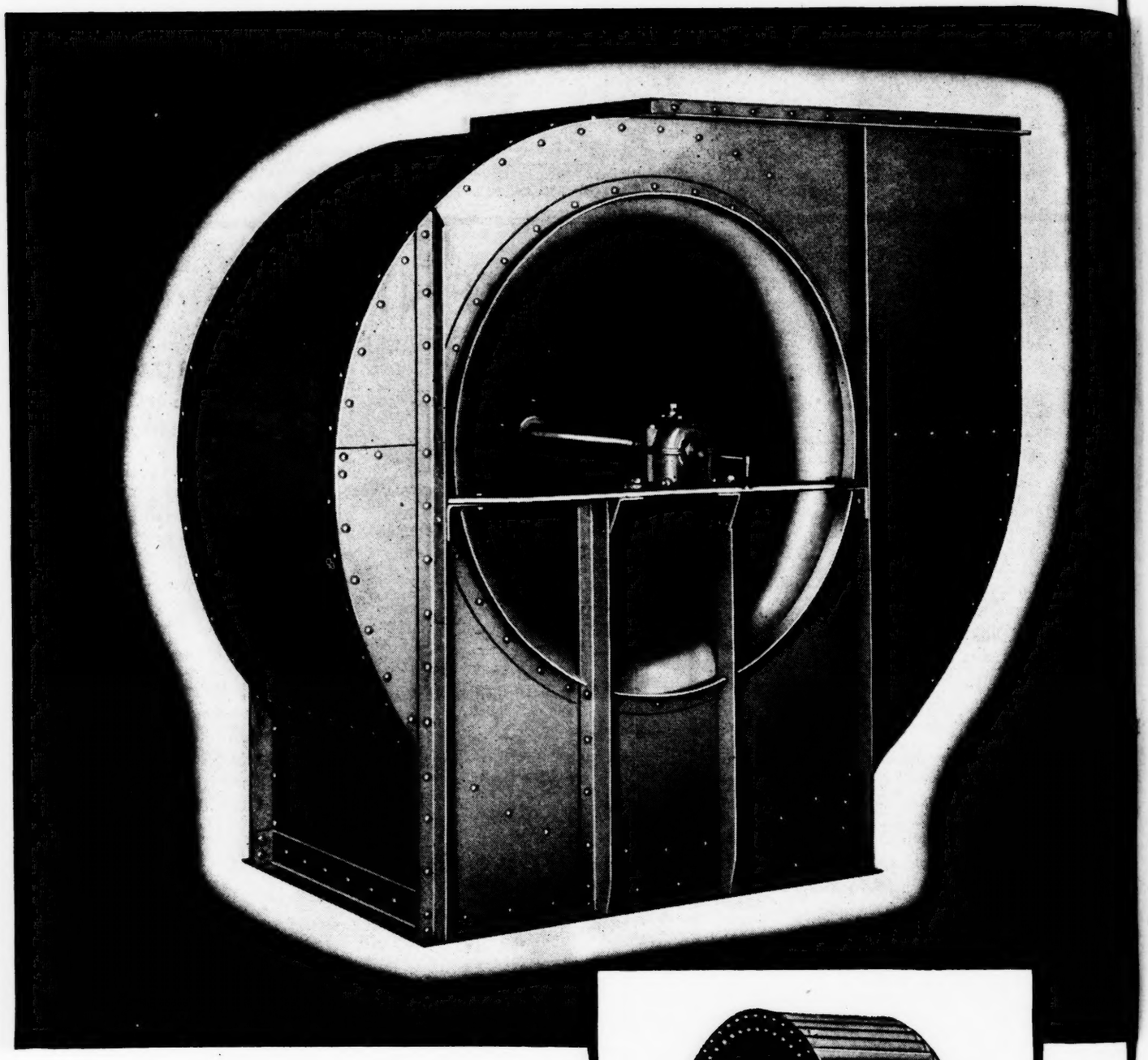
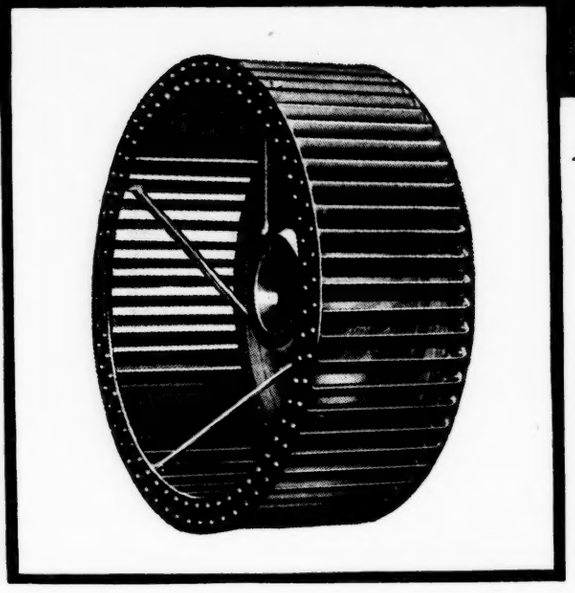
THIS MONTH'S COVER

Pipe grid, one of many types of panel at A. O. Smith Corp.'s new plant, is raised at one end to give graded depth of bury for heat transmission studies after concrete floor is poured. See page 59.





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Washington News

LORING F. OVERMAN

No Freight Cars.
ODT Revived.
Coal Shortage.
Building Supplies Improve.
Housing Outlook Mixed.

IT is always interesting to observe how a little tinkering with the laws of supply and demand or the normal flow of trade so often brings a number of unwanted chickens home to roost.

Current case in point is the increasingly serious freight car shortage. Six months or more ago, when the railroads pleaded for allocations of steel to replace war-battered rolling stock, they found that all steel was being earmarked for the veterans' housing program. Admittedly this was, and still is, a laudable objective. Yet, today, the very steel "earmarked" for veterans' housing cannot be completed because the railroads haven't freight cars enough to transport scrap to the blast furnaces. Too, the reduced amounts of steel that are actually completed are delayed in shipment, again due to the car shortage. With pricing policies more or less settled, "Let the merchandise roll," is the word that has gone out to shipping departments. But at the same instant, Mother Nature comes through with bumper crops of corn, wheat and other much-needed grain—and the East's industrial districts and the West's farms are involved in a scramble for cars.

H&V Groups Involved

That this new situation affects all who depend upon the heating, ventilating and air conditioning industries, is far too obvious. For the engineer and the architect, it means the delaying of completed projects; a further postponement of new projects due to lack of transportation for building materials. For the manufacturer it means a further slowdown in the arrival of components; delays in departures of finished products. For local dealers and contractors—more delays.

The National Association of American Railroads and the National Association of Shippers Advisory Boards has made a suggestion: that every freight receiver and shipper can have a part in tempering the shortage by making special arrangements for loadings and unloadings. Particularly desired are special provisions for Saturday and Sunday unloadings in plants where a five-day week is in effect.

Meanwhile in Washington, steps are being taken to rectify the six-month-old oversight. The Office of Defense Transportation, which was virtually considered a dead issue when the war ended, is now back into the picture in a big way. Contending that the shortage may run deep into 1947 unless strong action is taken, ODT has revised its carloading order to require higher utilization of existing cars, and is working on a plan to make more rolling stock available.

Finance is said to be one of the first problems in producing new freight cars, with a 25% down payment required with the order. Many railroads report this too heavy a burden, particularly since the replacement program involves several hundred thousand cars. As a starter, ODT is reported to have the Reconstruction Finance Corporation about convinced of the logic of a loan for some 50,000 cars. An even greater obstacle is the scarcity of steel, more than a million tons of which will be needed. The Civilian Production Administration, strongly committed to the Veterans Housing Program, is considering priorities for steel for underframes of cars, with aluminum suggested for body parts. Railroads are reported to question the serviceability of the lighter metal, but may have to compromise.

Sobering fact is that some 700,000 cars are now available; 300,000 of them beyond the retirement age by normal standards, with this year's car output estimated at 60,000. The anticipated addition of 50,000 more would obviously make only a small dent in requirements, for it is not expected the aging 300,000 can keep up for much longer the high-speed pace set by the war and continued today.

Coal Shortage?

Of equal interest to the heating and ventilating industries is the possibility that the current car shortage may also be reflected in a coal shortage. ODT has already urged coal distributors and shippers, as well as industrial users, to provide immediately for speedier unloading of coal cars, including Saturday unloadings. As a hangover of the two-month stoppage of mining last spring, railroads are being called upon to transport this year's coal in 10 months instead of 12, according to Col. J. Monrow Johnson, O.D.T. director. Present traffic conditions and the five-day unloading of coal are not only creating serious car shortages, but the car shortages are themselves resulting in curtailing of production in some coal fields. With the miners working a six-day week, he explained, the effect is inevitable. Cars must be returned to the mines because there are no means for storing coal between the time it is mined and shipped. Coal taken from the mine workings moves to the pit heads and from there direct to empty cars for shipment.

To emphasize the significance of the car shortage, Colonel Johnson pointed out that the 21,000 coal car shortage reported for the week ended July 27 represents an equivalent production loss of about 1,150,000 tons of coal.

Added to other shipment problems, the ocean export coal movement—over three times as heavy as last year—involves a number of long hauls and consequent increases in turn-around time. Indiana and Illinois coal is being hauled to Gulf ports. Utah coal shipped to Long Beach, Cal., and Portland, Ore., for transshipment calls for rail hauls of 1,000 to 1,200 miles. Ocean export coal loadings to August 1 amounted to 10,323,000

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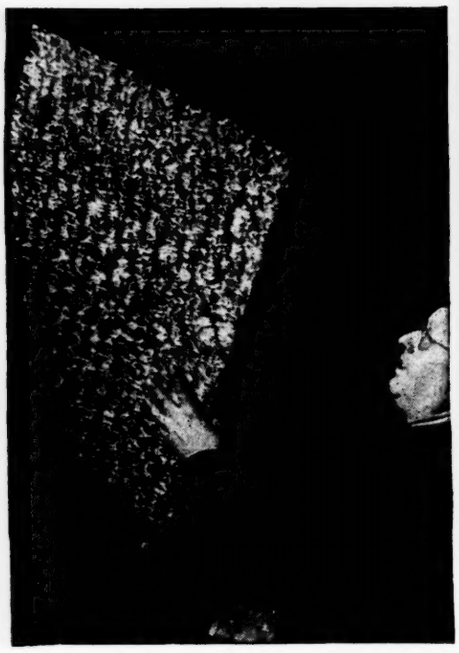

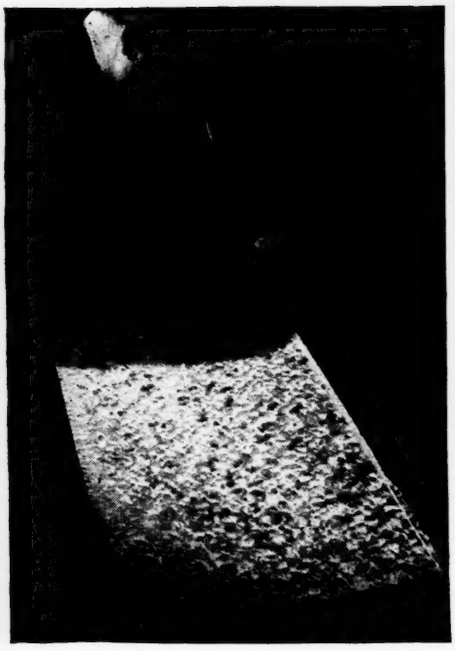

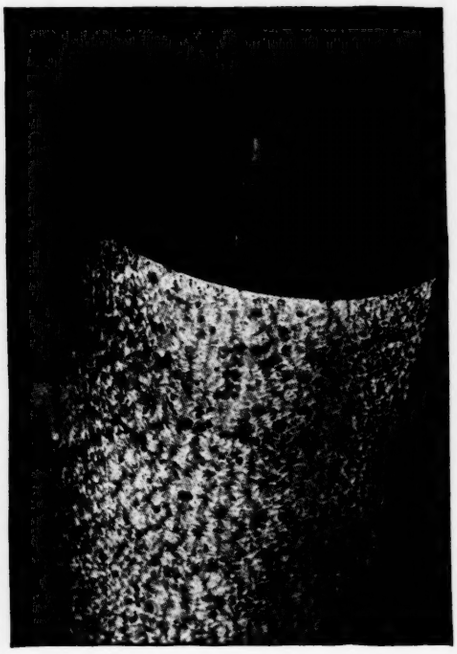

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They're easy-forming

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because of the full, bright spangles, insuring pleasing appearance in the finished job, and a product which has added sales appeal.

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tons compared with 3,000,000 tons for the same period of 1945. July shipments alone, amounting to 2,396,000 tons, exceeded the total shipped during the entire pre-war year of 1941 by 123,000 tons.

Building Materials Up

Despite the new transportation threat, steady increases in the production of a number of critical building materials was reported on August 15 by Wilson W. Wyatt, National Housing Expediter. Brick production increased 11% in June, the first month of operation of the Veterans Emergency Housing Program premium plan, and rose an additional 17% in July. CPA's estimate of July production of 457 million bricks was more than twice as high as in August, 1945, when the war ended.

While June lumber figures were not available for Mr. Wyatt's report, May production registered a gain for the fifth consecutive month and exceeded 3 billion feet for the first time since August, 1944. Preliminary CPA estimates indicate the June production maintained the high level reached in May. As a result the CPA has revised upward its official estimate of total 1946 production—from 30 billion to 32 billion feet—not including a billion feet expected from imports.

NHA points out that the increases do not yet reflect such actions, taken since May, as the building of access roads to remote timber lands, overcutting in U. S. Forests, and premium payment for standing timber on state-owned lands. Recent OPA price increases are also expected to prove an incentive for added production.

Other materials that hit post-war highs in June included clay sewer pipe, structural insulation board, and shingles. Asphalt roofing set an all-time record. Cement, bath tubs, gypsum board and lath, asbestos roofing and siding, and nails also registered gains in June over May.

June production declines were sustained chiefly in items made from iron and steel, but correctives expected to improve the situation have been taken. The correctives include those now being reflected in shortage of steel for freight cars. For example, manufacturers of a large number of plumbing and heating fixtures have been authorized by CPA to submit certified orders during the third quarter to steel producers for the steel they need in the production of pressed-steel bathtubs, sinks, lavatories; warm-air furnaces and floor furnaces; convector radiation; furnace pipe, fitting and duct work; steel registers and grilles. Steel producers are required to fill such certified orders ahead of unrated orders.

Similarly, producers of cast iron products used in housing have been authorized to issue certified orders for castings to foundries; while foundries, in applying to CPA for pig iron needed for casting, must agree to use the pig iron in castings for the critical building items specified in the directive. The items include cast iron soil pipe and fittings; pressure pipe and fittings; bathtubs, sinks, lavatories; radiation, warm air furnaces and floor furnaces; and low pressure boilers. The directive applies to August and September.

The need for this action is shown in June production figures. Cast iron soil pipe output dropped 16% from May, attributed mainly to seasonal decline in foundry operation and low production of pig iron and coke. In addition to the priority action taken, cast iron soil pipe has been added to the list of critical products covered by the premium payment plan, effective as of August 1.

Among heating equipment, cast iron radiation dropped 5% below May, convector radiation 9%, and warm air furnaces 2%. The priorities action, plus a premium plan applicable to convector radiation, effective August 1, is expected to halt the decline.

Housing Program Status

Status of the veterans' housing program is something of a question-mark. Discussion is reminiscent of that old yarn about the three blind men who respectively decided that an elephant must be like a wall, a tree, and a snake—depending upon whether his side, leg or trunk was examined.

Wilson Wyatt's NHA propagandists relate in glowing terms that "the first six months of 1946 found 496,000 living accommodations started under the Veterans Emergency Housing Program, while completions were registered for 225,000 units on which starts were made before and after the inception of the program."

On the other hand, Omar D. Ketchum, head of the Legislative Service of the Veterans of Foreign Wars, said the servicemen's organization plans to ask Congress for a bi-partisan investigation of "the breakdown of the program." Ketchum's dissatisfaction was reflected by VFW Housing Officer Wesley Pearce, who observed:

"Private builders have said they can produce houses for veterans. Let them start producing or admit they can't or won't, and step aside for Government construction on a long-scale program. We are also going to demand that the CPA quit stalling on the HH priority system. We will ask that such priorities be extended to the producer level to force producers to set aside needed materials, and thus make the priorities mean something."

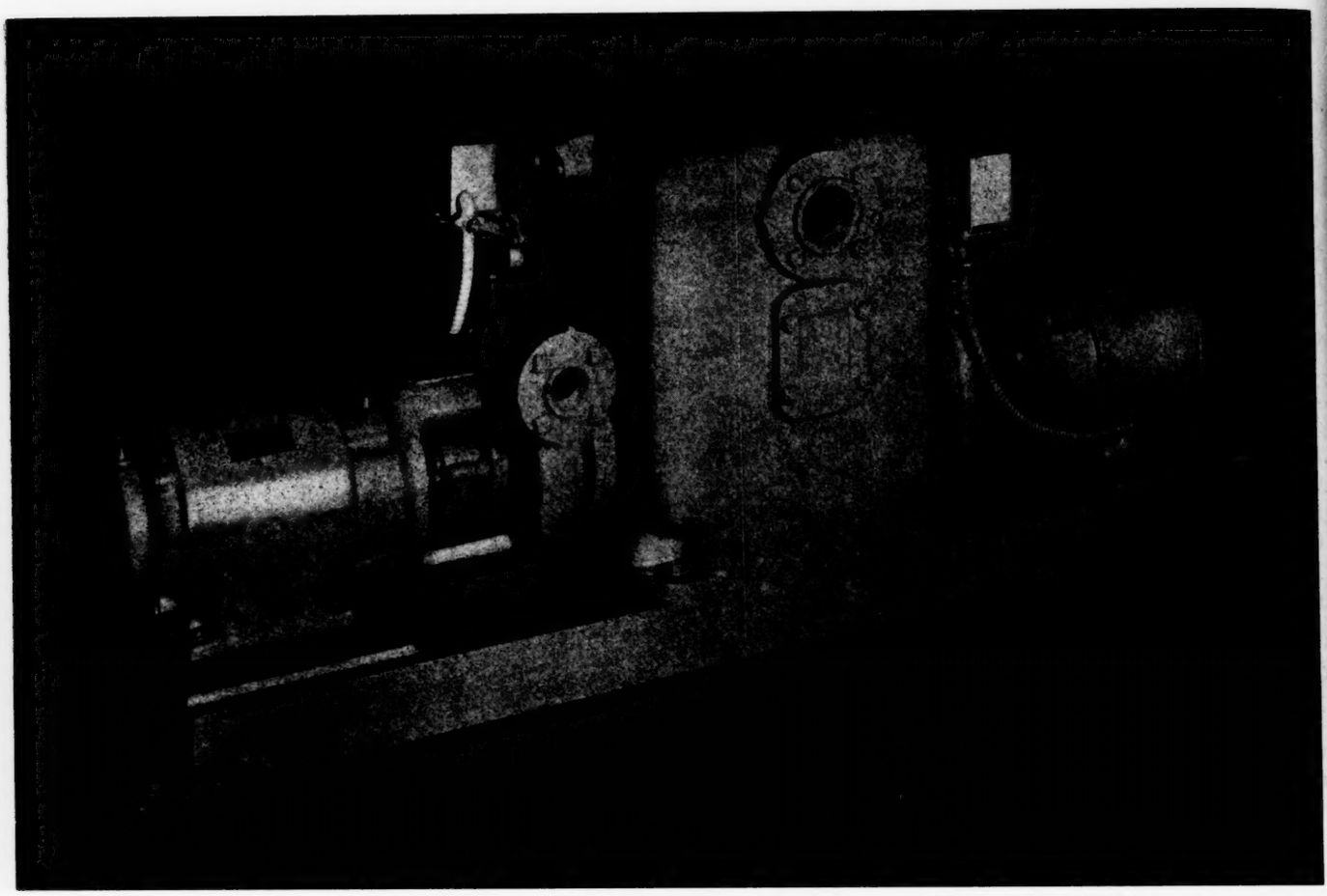
"Time to Get Tough"

Whatever may be thought of the Wyatt program, there is little to indicate that an early easing of restrictions on commercial or industrial building is in prospect. Speaking before the Veterans Advisory Council in Washington on August 22, Mr. Wyatt said:

"Tough action is needed and such action is justified at the present time." He was promising a series of sweeping steps to speed up the housing program—let the chips fall where they may. "Non-residential construction cannot be permitted to continue diverting the present volume of materials from veterans' housing," he continued.

The actions now in preparation will affect a dozen critical building items, shortages of which are causing bottlenecks in construction. The priorities list, which now contains only 25 materials groups, will be doubled. Chief emphasis of the new actions will be to insure that producers and distributors of materials actually hold them for use in the veterans' program.

MAXIMUM EFFICIENCY FOR STEAM HEATING SYSTEMS ON HEATING, DRYING AND PROCESS WORK.



JENNINGS CONDENSATION PUMPS

Designed for steam systems on heating, drying, or process work, these pumps offer the most reliable and efficient means of returning hot condensate to boiler or hot well. In many cases these pumps will save costly installation of boilers in a pit to provide gravity flow of returns from basement radiators and heating devices.

The Jennings Condensation Pumps are sturdy and compact in construction, and combine receiving tank, pump and driving motor in a single assembly. Pumps are bronze fitted throughout, with tobin bronze shaft. The pumping impeller is of special design, made possible by our wide experience with return line heating pumps, and is especially adapted for handling hot water with the greatest possible efficiency.

Full automatic control is furnished by means of a ball float and float switch mechanism mounted on the receiving tank. All wiring is made up at the factory, and it is necessary only to connect the pump to the system and hook up the leads. Complete information regarding these economical pumps sent promptly on request.

THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

INDUSTRIAL PLANT FEATURES

Variety in Radiant Panels

Great flexibility in layout is provided in heating the Kankakee, Ill., plant of A. O. Smith Corp. Wrought iron, steel and copper pipe are used in several piping arrangements for floor and ceiling panels. Plant is divided into 10 zones heated by 120 boilers serving as many separate systems.

Site of appliance testing laboratory on the mezzanine floor. Bundy tubing, in loops about 100 ft long, is placed in the 3 in. thick roof decking.

FORTY miles of pipe were used in the construction of a radiant heating system at the new Kankakee Works of the A. O. Smith Corp., at Kankakee, Ill. This system, composed of wrought iron, copper and copper clad steel tubing, is designed to circulate 15,000 gallons of water 12 times per hour or a total of 180,000 gph.

The plant, which is expected to be in operation late in September to produce about 250,000 gas heaters annually, is 1,200 ft long and 315 ft wide, largely of one-story construction. The ground floor area is 381,750 sq ft. Located on mezzanine floors are 10,650 sq ft floor space for laboratories and 22,788 sq ft for offices. The building is so designed that there are 48 bays with each bay consisting of two units and two heating coils for each unit. A bay is 25 ft deep, runs across the 315 ft width of the plant, and is served by two gas-fired heaters.

A wide variety of coil arrangements and coil sizes is used. Piping consists of ¾- to 2-in. wrought iron; ⅜- to 1-in. copper; ⅝-in. Bundy steel tubing with a copper lining and copper outer jacket. While primarily good engineering logic governed the selection of these materials, other factors were necessity and exigency.

The coil arrangements used are sinuous coil, sinuous coil with header, and grid coil in the floor. Eighty per cent of the plant floor installation is of grid type construction consisting of wrought iron headers and laterals. Some of the grids have 2-in. headers 140 ft long and laterals of 1¼-in. pipe, 20 ft long. Other grids have 20-ft headers and 140-ft laterals. Center to center dimensions range from 4 ft down to 8 in. The closer spacings are near the exposed outer walls. In some instances, to gain additional pipe length, a single straight pipe run is placed in the exposed side wall just below the ceiling.

Grid type construction was selected for the major part of the floor area because it is the system most adaptable to possible future changes in both floor arrangements and foundations. New headers can be installed around the new foundations as needed and mass production of headers and laterals makes possible welding at the place of manufacture rather than on the job. Besides, the use of random lengths of pipe is possible.

A combination grid and sinuous coil construction is used for nearly 20% of the plant floor. This design was chosen because the company was able to obtain pipe for sinuous coils but not for grid type laterals. However, headers are introduced into the design to—

1. Reduce resistance to flow where the friction loss is too great for the capacity of the pumps.

2. Guard against difficult alterations resulting from changes in floor arrangements and foundations.

Kankakee Works of the A. O. Smith Corp. Building is 1,200 ft long and 315 ft wide.

One result of using headers in a sinuous coil panel is to break up the panel into two or three smaller sinuous coil circuits.

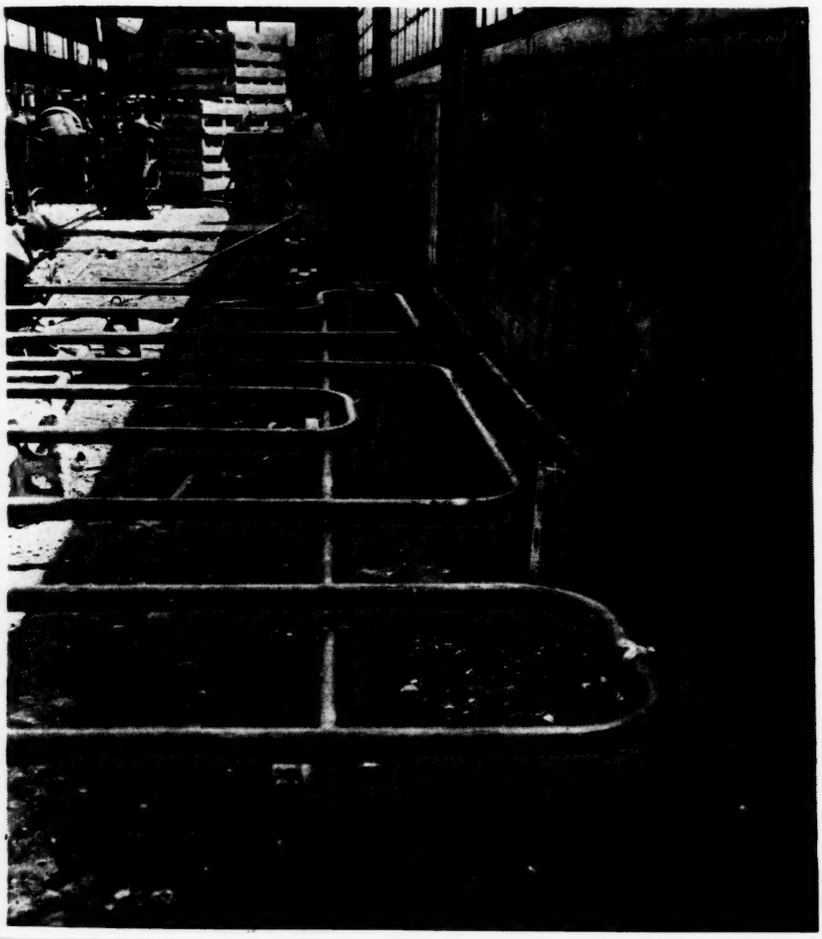
In an unusual pipe arrangement (see cover photograph) the supply header to the floor grid is raised above the floor near one of the exposed side walls. It will permit the study of heat flow through various thicknesses of concrete floor.

For the 10,650 sq ft of mezzanine floors, $\frac{5}{8}$-in. Bundy tubing with a wall thickness of 0.049 in. is used because it is available and fits the thickness of the concrete floor slabs. Grid layout is used with center to center distances varying from 6 to 12 in., depending upon the estimated rate of heat loss.

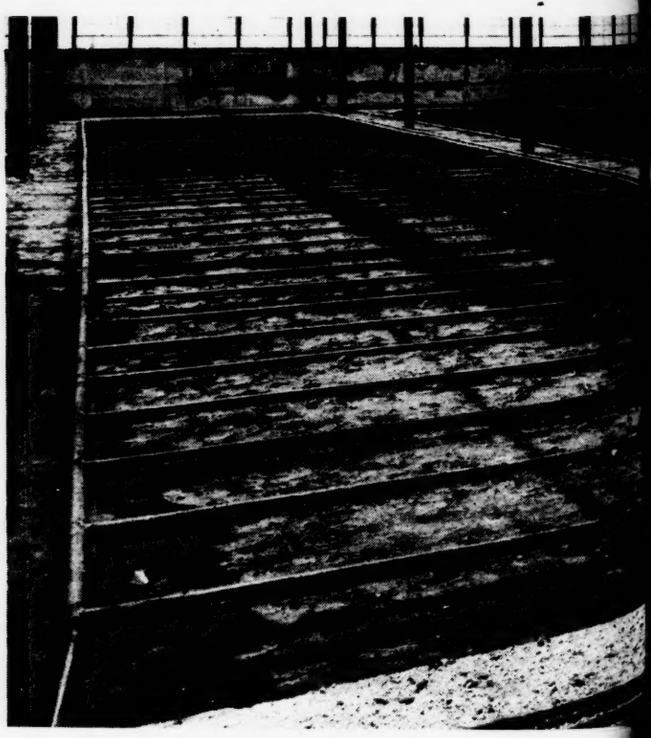
For the 22,788 sq ft of first floor offices, wrought iron grids are used. In the ceiling of these offices there is an auxiliary wrought iron surface at the outside exposure to add radiation and also to provide additional heat at the windows for the second floor offices. Grid and sinuous coil construction with copper tubing is so installed in the ceiling of second floor offices that the heat is directed downward. In most of the offices and laboratories, ceiling panels consist of $\frac{1}{2}$-in. copper tubing covered with $\frac{3}{4}$ in. of plaster.

An area of about 50 × 100 ft in the railroad car loading section does not have a floor panel. Pouring of concrete had started before the final heating plans

Combination grid type and sinuous coil construction with 2 in. wrought iron pipe. Concentration of pipe surface is at the outside wall.



Typical grid construction consisting of 2 in. wrought iron headers 140 ft long with $1\frac{1}{4}$ in. laterals 20 ft long. Center to center spacing varies depending upon rate of heat loss.



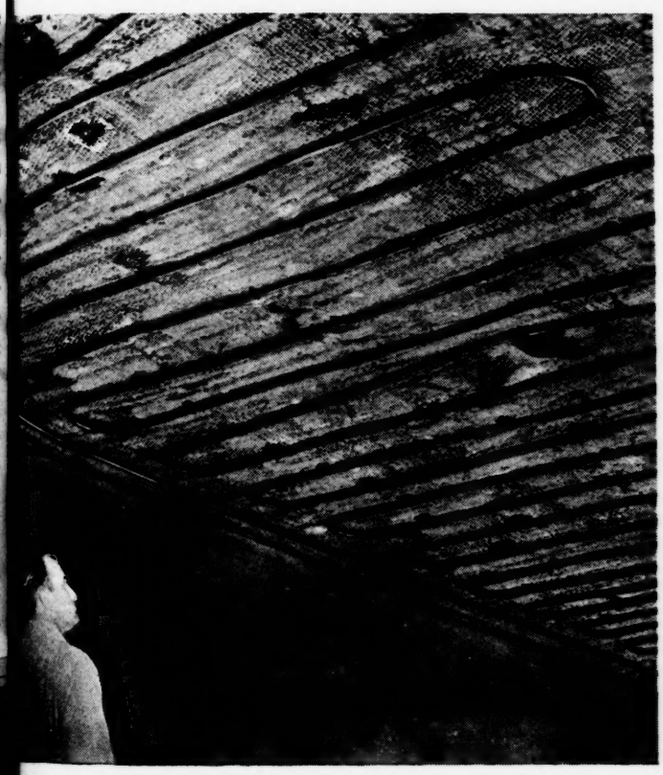
had been completed. It is probable that this section will be served by suspended heating panels.

Provisions are made for removing air from the large floor coils. It is believed that the pressure existing in the small tubing coils in the ceiling will take care of any air pockets.

Water in the coils and grids is circulated by Bell and Gossett circulators which move 25 gpm. From 5 to 8 gpm are circulated through the heater and the balance is by-passed. This water has a maximum temperature of 140F and 50 to 60 lb per sq in. pressure. The system is designed to give a 15F drop through the coils, a slab surface temperature of 85F and an air temperature of 65F.

120 Heaters

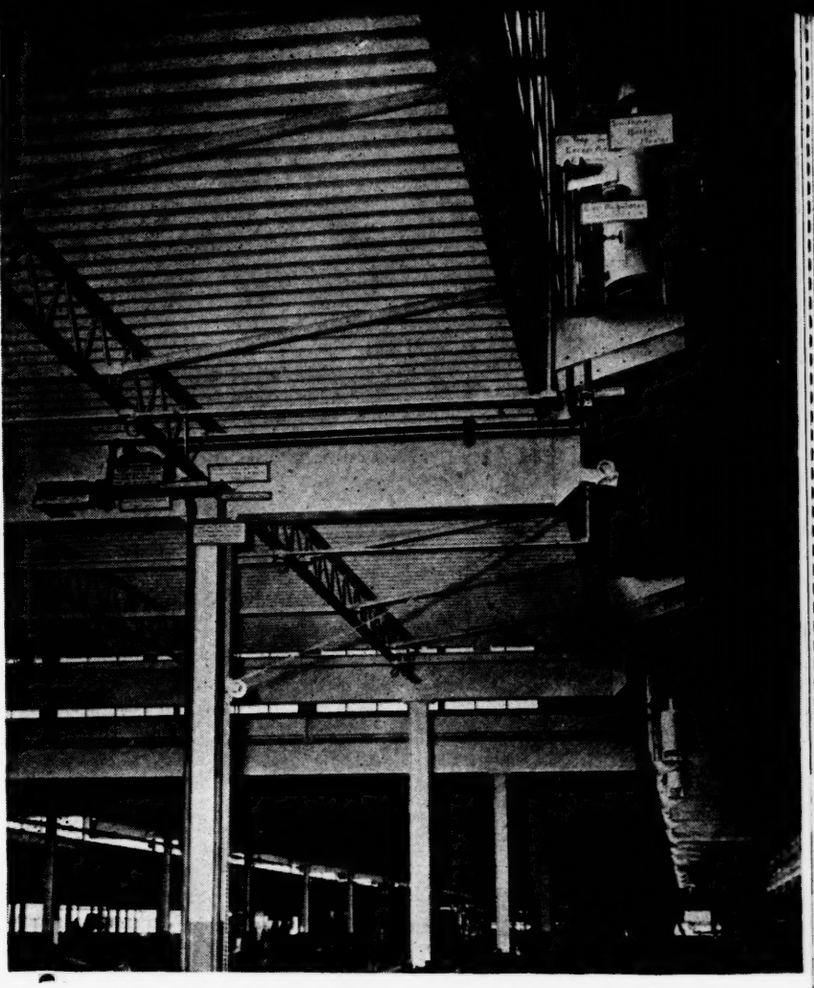
Heat will be furnished by 120 Smithway-Burkay volume water heaters. These flash type instantaneous gas heaters, which will burn natural gas, are manufactured by the Burkay Co., Toledo, Ohio, and are distributed by the A. O. Smith Corp. Heaters have a rating of 190,000 Btu per hour when using 1,000 Btu gas. The company will be able to check on a large group of their heaters under constant operation conditions.



Copper tubing installed on the scratch plaster coat of the second floor ceiling. Over this is placed ¼ in. brown coat and ½ in. acoustical plaster coat.

Heaters are mounted on steel platforms in the roof monitors. Combustion gas is carried off by a small pipe through a monitor window. Units have throttle-flow thermostats and modulating burners.

The large group of heaters, each unit virtually serving a small heating system, provides flexible control.



One of the 120 Smithway-Burkay water heaters which supply hot water for the heating system.

In addition, for purposes of zone control, the entire plant can be considered as being divided into 10 zones as follows: North, 1; south, 1; east, 2; west, 2; office and laboratory section, 4.

Controls consist of Johnson Service master and submaster thermostats for readjusting floor panel temperatures in accordance with outdoor temperature changes. The 10 master zones are coordinated with sidewall temperatures and outdoor exposures.

Besides the 120 units for space heating, 4 heaters are installed to maintain 42F water in the 100,000-gallon tank that serves the automatic sprinkler system. Steam for operating two large compressors and for processing applications is supplied by 3 Kewanee boilers.

A snow melting system is provided from the parking lot to the shop and office entrances. Two-inch pipe is used on 2 ft centers in 8 ft walks.

An interesting sidelight of this industrial project is that blue prints are available which show the exact location of every weld, joint, bend, header and lateral in the entire plant. Some of the panels are outlined in color on the floor to help in setting machinery.

Construction Credits

C. W. Colby, who has been with A. O. Smith Corp. since 1945, designed the radiant heating system and served as engineer in charge of installing the system.

B & W Construction Co., Chicago, is the general contractor. The heating contractor is the Colton Corp., New Haven, Conn. This contract covers all gas, air and water piping.

Buying Used Mechanical Equipment

ROBERT H. EMERICK
Consulting Mechanical Engineer, St. Petersburg, Florida.

For the purchaser of used mechanical equipment, here are a number of suggestions that may avoid costly repairs. Attention is directed to the tell-tale signs of possible hidden mechanical trouble and how to interpret the findings. This article covers the equipment commonly used in the fields of heating, ventilating, air conditioning and industrial refrigeration.

BECAUSE of the liquidation of wartime government assets, users of machinery and equipment will have the opportunity to buy many items at favorable prices. Some of the machinery was stored for possible war use and was never used; other units have histories of careless or unintelligent operation. Although all are likely to be offered as bargains, not all of the claims may be justified.

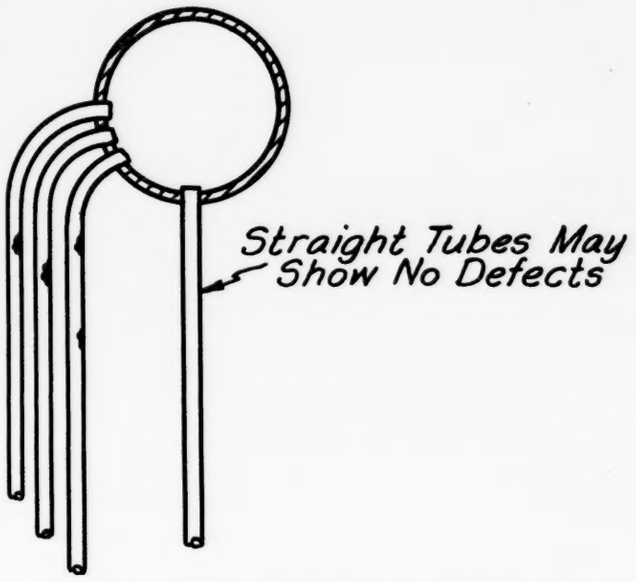
However, if we are buyers, the problem is not primarily to find a bargain but to spend our money for equipment that will give dependable and efficient service. A purchase based on any other premise may be one of grief.

If we must ship our purchase some distance, and this is most generally the case, the cost and safe arrival of our material is charged strictly against ourselves. For example, damages incurred in transit are not always discovered until perhaps a much later date. An assembled boiler may be strained in handling, or even dropped, and not until the hydrostatic test is made, do we learn that many of the tubes must be re-rolled. This repair cost must become part of the purchase price. In fact, we can never be sure of the true purchase price of any used piece of machinery, until we have it set up and operating satisfactorily.

We rarely are able to test-operate equipment before we buy it. Fortunately, however, deterioration and defects tend to betray their presence in ways and places peculiarly related to their causes. If we know where to look and what to look for, we sometimes can find conditions not known to the seller, nor evident in the unit's maintenance history.

Water Tube Boilers

Internal corrosion is made manifest by the presence of pits, or tiny craters, on the inside surfaces of the drums and tubes. Ordinarily, but not always, the presence of corrosion can be determined without difficulty by a simple inspection of the drum internals, and the tube ends. The exception is the boiler. In this boiler the drums and tubes will all look quite good, but if we pull a couple of tubes, and split them, we may find deep pits two or even three feet from the drum. Pits in this location appear to be the result of a high rate of local steam release. Steam bubbles forming against the tube wall, deposit minute quantities of oxygen, and corrosion proceeds merrily. Whether the pitting is serious or not depends on its depth and its nature. A single, deep crater betokens a shorter life than does an area of shallow, pinpoint depressions, for the single crater indicates a concentrated progress toward failure.



Corrosion below the tube bends in a bent tube boiler.

Boilers represent a substantial investment and are not infrequently the very heart of a plant. Before we buy a used water tube boiler of the bent tube type, we will be on the safe side if we pull a few representative tubes and split them open for inspection.

While external corrosion should be evident, this is not generally true. If a tube has been leaking at the point where it is rolled into the mud drum, and soot has accumulated over and around the leak, serious corrosion might be progressing steadily under the soot, for soot frequently contains sulfur, and this sulfur mixing with water from the leak, produces a weak sulfuric acid. The way to be sure that the drum is in good health is to clear away soot deposits and inspect the surface. Clearing soot accumulations in these areas is not easy but hot water, delivered from a nozzle at high pressure, often does the job satisfactorily.

Overheating in a boiler would come in the category of obvious conditions, except for one piece of misleading evidence—the presence of warped tubes. Although warped tubes do not indicate conclusively that overheating has occurred, these more or less distorted shapes might be the result of setting strains, or simply uneven expansion throughout the boiler as a whole. If warped tubes are not in contact with adjacent tubes under any conditions of operation, then their shape alone is not sufficient reason for their removal and replacement.

Straight tube boilers, on the whole, are easier to inspect than their bent tube cousins. Nevertheless, two ailments, not obviously under our noses, must be considered.

(1) Corrosion of the header nipples that connect the headers and the mud drums. Unless the boiler is in clearly excellent material condition, cutting out one or two of these nipples for inspection is a wise precaution.

(2) Longitudinal movement of tubes during temperature changes has been known to groove deep tracks in the tubes from the friction of their contacts with the baffles, if the baffles are of cast iron. Usually, the boiler operator discovers the presence of these grooves only when the tube lets go and dumps the load. This trouble does not always occur and why it occurs in some boilers and not in others is not known either. To be sure, an inspection of the tubes in the vicinity of the baffles is certainly in order.

Fire Tube Boilers

Probably all ailments, except one, of fire tube boilers are pretty obvious. This one concerns crystallization of stay bolts. There is only one safe way to be sure that these bolts are not going to get tired and quit their important jobs just when we most need the boiler's overload capacity. We must pull one or two and make a laboratory check.

Steam Turbines

One of the first things we consider when buying a used turbine is the possibility of a warped rotor. If the rotor is a heavy one, and the machine has not been running for a long time, there is even the possibility that the rotor has taken a permanent bow. If this be the case, we can expect vibration, early destruction of the metallic packing, leakage between stages, misalignment from uneven wear in the bearings, and an efficiency so low we will never mention it outside of the family.

Other non-obvious ailments of a steam turbine include steam cutting around the nozzle block, excessive erosion of nozzles due to wet or dirty steam, steam cuts between the stages across the fixed blading, internal casing corrosion, surface scores, and out-of-round conditions of the journals.

Journals of course are readily inspected, simply by

lifting the caps. For the others, we have no safe procedure except to lift the casing. When we do get it up, a good plan is to rotate the rotor in the lower halves of the bearings, with a dial indicator on each journal. If we find the journals badly scored or something else than round in cross section, we might start figuring then and there that the selling price of that turbine will be increased by a journal machining job, plus the cost of new bearings. A dial indicator located between stages at the same time will show the magnitude of a bow, if any.

Loose blading is best picked up by ringing the blades, the sound of a wiggly blade being quite different from the sound of its solidly seated neighbors.

Sometimes labyrinth packing can be re-shaped, if the sharp edges have been rolled over by rubbing. This job is not expensive, and in an old turbine is often to be preferred to buying new sections. The old sections are well run in, and sure to fit, which is something we can't always be sure of with new ones.

Reduction Gears

If a reduction gear runs quietly, we can be reasonably sure the gear is all right. If we must take it without running, our only recourse is to lift the casing and examine the gear and pinion with some care. Misalignment is the heart disease of a reduction gear. Evidences of misalignment are: Scored or flaked teeth; teeth with rolled edges; uneven wear of the bearings and journals. Pitting, often present on gear teeth, means merely that the oil has been inadequately kept clean of water and dirt. When running, the pits fill with oil, and contribute no hindrance to the satisfactory running of the gear. Flaking, when it has occurred at the ends of the teeth, suggests that the gear might have been overloaded. When flaking is observed, a good plan is to obtain, if possible, some information on maximum running temperatures. If these temperatures have been inordinately high, the possibility of a past overload are good. Whether we want this gear or not, depends now on the load we intend to impose on it. If our intended load falls in the neighborhood of the past overload value, our best plan is to look for another gear, else we shall have continual worry and trouble.

Our old friend the dial indicator, set up on the band shoulder of the gear, will tell us if the gear is out of round. Some manufacturers state flatly that for out-of-round, there is no tolerance. Others fix 0.004 in. as the maximum allowable. Actually a gear *may* run satisfactorily with an out-of-round value of as much as 0.007 in. However, if we set the medium limit as our guide, we will be safe. Correction, should we consider it, is a factory job.

Matching old gears with new pinions, or vice versa, rarely produces a smoothly running gear. Neither does a correction of misalignment, if the misalignment is substantial. In either case we upset the established contact areas of the teeth, and the running in, like most new marriages, produces a certain amount of noise. If we are sensitive to such things, a good idea is to take a vacation, while the gear is making peace with itself.

Centrifugal Pumps

A centrifugal pump is expected to deliver so many gallons of something at such and such a head. If it fails to do this, the reason will be found in worn wearing rings; eroded and corroded buckets in the rotor; ditto for the discharge passages. Of course if the suction lift is too high, or confused by too many elbows and fittings, or of the wrong size, we should see these things from the start. They belong in the realm of the obvious.

The only safe approach to the purchase of a centrifugal pump, unless the pump was never used, is to open the casing and examine the vital parts. Odd noises, sometimes generated by a running pump, have been found due to old shoes, fish, nuts and bolts, large rags. These may accompany our purchase at no extra charge, unless we look first.

Positive Displacement Pumps

Rotary pumps, screw pumps, reciprocating pumps, all depend for their efficiency and satisfactory operation on the maintenance of certain small clearances. The first question concerning pumps of this nature should be, "What has it been pumping?" immediately followed by others on the time in operation, and date of last overhaul, if any.

Abrasive and corrosive fluids can terminate the efficient life, and sometimes the whole life, of a pump with surprising speed. Even on bland fluids, if the pump has been running a long time, the need for new liners, new gears, or new worms, according to the nature of the machine, is something we must anticipate. We can tell this from the hours of operation, even in the absence of other evidence, before ever making an inspection. It's the plain procedure of estimating pump life, elapsed and expected.

Steam Engines

The things we can't see, standing alongside a steam engine, usually provide us with the most trouble and expense. These defects include out-of-round and barrelled cylinders. Because of a misalignment between a cylinder and the crankshaft below, the piston rod bangs out the gland packing the slippers are cruel to the guides, crankshaft and connecting rod bearings wipe out, and the piston itself hammers its head against the cylinder wall to the ultimate distortion of both.

We can't look through the walls of a steam cylinder, but we can ask some mighty leading questions, intended to find out about internal conditions without lifting the cylinder head. We can ask about the wiping of bearings. If any one bearing has been failing with fair regularity, and the engine has not been consistently over-speeded, we can suspect misalignment as one of the causes. How about the gland packing of the suspected cylinder? Is it hard to keep tight, and does it blow frequently? The evidence is beginning to bolster our suspicions.

How often, if ever, has it been necessary to change rings and in what cylinders? Are there any records of cylinder dimensions taken with inside micrometers? Over a period of years these dimensions provide a clear road map of how a cylinder is wearing, and why.

Data like these can terminate our interest in an engine, for to overhaul and align a steam engine, particularly a big engine with more than one expansion, is a lengthy job, often running into weeks. What the cost of such a job can add to the purchase price is mighty discouraging.

There is another ailment sometimes found in engines that appears an obvious reason for rejecting the proposition, but frequently is not. This is the presence of porosity, or a hairline crack in the cylinder wall. A patch bolted over the defective area can be all the treatment needed. Such engines, like the cracked pitcher, can, and do, go on for years and years, and never give a moment's trouble. Of course, if there happens to be a choice of engines, we will not prefer the cracked one to the uncracked one, but this kind of a blemish need not be the sole reason for rejecting an otherwise good engine.

Oil Burning Equipment

As a rule, if we have the chance to buy some used burner equipment, we will find that a boiler goes with it. Burners, air registers, nozzles and fans probably will need cleaning more than any other treatment. If we allow 20% of the cost for this cleaning, and minor repairs, we shall consider ourselves safe.

If a heater is included, and the heater is old in service, we shall find almost certainly that the heater is leaking in one place or another. Since 100% of the purchase price is likely to go into cleaning, repairs and testing, we must regard used heaters without much enthusiasm.

Fuel oil burning equipment, being comparatively small and easily handled, has a tendency to disappear during shipment, particularly if it happens to be loosely included with a boiler. Insurance against theft is just one more item to be added to the purchase price.

Stokers

Except for spreader stokers, which heave coal into a furnace from a comparatively safe place, all stokers are faced with the danger of overheating and burning. For protection, they depend on the layer of ash, left by the burned coal, and on the air of the draft, rising through the stoker and the bed of burning coal. Burned parts are readily seen and replaced; overheated ones, well on the way to crystallization and failure, are not so obvious.

We can gather some idea of the average danger a stoker has experienced, by checking the ash content of the coal it has been burning. Low ash, much danger; high ash, less danger. If the ash generally has been less than 6%, we might suspect the worst.

About this time let us consider the air. The use of highly preheated air places an added burden on stoker materials. Temperatures over 300F, combined with low ash coal, shorten the life of stoker parts. Conversely, a moderate or zero preheat, introduced under a bed of high ash coal, provides the maximum of protection.

Unfortunately high ash coal is never bought happily, for no one likes to spend money for ashes, and the disposal of much ash is a problem itself. Plant operators usually like all the preheat they can get, because Btu going up the stack, except for enough heat to hold the temperature of the stack gases above the dew point, is considered plain waste.

Whatever the stoker is, unless we have evidence it has never been operated, or has been operated infrequently, we should add to the purchase price a percentage for new parts, the need for which may not develop until the unit is being re-erected, in our own plant.

Fans

All fans are subject to getting out of balance. If the fan has been running satisfactorily, the chances are we will find it to be in acceptable balance. However, if it is an induced draft fan on a boiler, handling hot gases and cinders, erosion is certain to have progressed to some extent, and the wearing away of metal on the rotating element will lead sooner or later to a balancing job. Sometimes imbalance is caused by accumulations of cinders and dirt, and for such cases a simple cleaning of the blades often is sufficient.

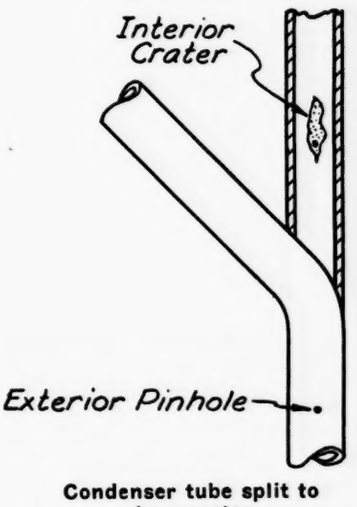
If the fan has been used for space ventilation, it might be almost as good as new, but if it has been used to remove corrosive gases, then we can expect to spend some money for repairs, either now, or in the immediate future.

Most of these defects are apparent by looking at the fan, but if we know also that the air it has been handling is unhealthy for metals, we will look more closely. There is always the possibility that the casing, or even the fan blades, while looking quite good on the surface, actually may be mere shadows of what they once were.

Condensers

Suppose we consider a condenser that has been in service on salt or brackish water for, say, three years, and up until a few months ago never needed a tube replacement. In all, only six tubes have failed, and all these failures occurred recently. Is it a good buy?

It is a good buy only if the price is very, very low, because those recent failures indicate that dezincification finally is catching up with the tubes. Unless we are ready to take the condenser out of service every couple of weeks to plug a tube, we can prepare ourselves to do a complete retubing job. If this sounds extreme, we can pull a couple of tubes, split them, and see for ourselves the progress of their ulceration. Tubes may be perfect in appearance to casual inspection, but here and there, sometimes not oftener than once in a tube, we will find a pinhole, or an incipient pinhole. On the inside surface, this pinhole will be the point of maximum depth for a crater that resembles

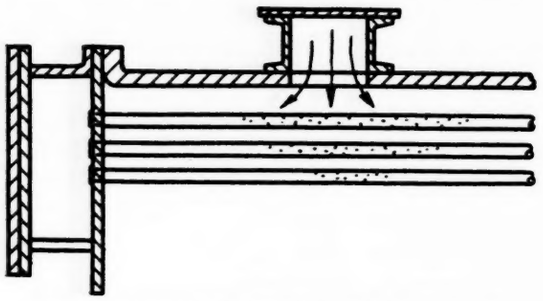


Condenser tube split to show crater.

a miniature Grand Canyon, even to the multiplicity of colors.

Dezincification is a chemical prccess resulting from salt water acting on the zinc constituent of the tube metal, aided and abetted by electrolysis. The salt water simply acts as an electrolytic solution. If the salt water is warm, the deterioration of condenser tubes is speeded; cold water slows it down, but the process is not stopped, even in the Arctic. We can estimate the life of our used condenser tubes by considering their time and temperature history, in the light of the water and temperatures of their proposed new service.

Tubes likewise are subject to erosion, particularly at the water inlet ends. If the condenser has never been



Tube destruction from steam impingement in condenser.

fitted with tube inserts, or if preservative measures have been taken but recently, then we can expect to find erosion varying from severe to a mere trace.

We should find out also, if possible, if there has been any trouble with erosion of tubes directly under the steam inlet. Sometimes water droplets carried into the condenser at high velocity dig into external tube surfaces as though they were looking for buried treasure. What they turn up, of course, is simply trouble for ourselves. The cure for this sort of attack is a baffle to take impingement.

One thing is sure. If we buy a condenser of large size, we can expect to find some leaky tubes when we test it, after re-erection. Shipping and handling tend to stress, perhaps only lightly, the tight joint of tube and tube sheet, but even a light stress is enough. Small condensers are less subject to these handling stresses and may come through without a drip.

Air Compressors

If an air compressor has been operating for a long time we expect it to need a valve job, and perhaps new rings. There might also be present some cylinder scoring, but if the machine's output has been normal, both in volume and pressure, we can assume that scoring, if any, is not serious.

As the inter- and after-cooler of a compressor are basically little condensers, we will ask about the character of the cooling water, and if retubing has taken place, either ever, or recently. These units are small, and retubing is not a very expensive job. The chief reason for obtaining this information is to protect ourselves against a stoppage of the compressed air supply at an embarrassing moment.

Just to be on the safe side, when we buy a used air compressor, we will add a small percentage of the purchase price to cover possible repairs, before we put the unit in operation. Of course, if we know that certain repairs will be needed, the actual cost can be anticipated with some accuracy, but our problem is to foresee, and allow for, the non-obvious defects.

Refrigerating Compressors

With one exception, large compressors are subject to the same ills that beset air compressors. They are not commonly concerned with coolers. In refrigeration work, most compressors act as single step units, and consequently there is no need for interstage coolers with such units. If booster compressors are used, as in low temperature work of, say, —30F and lower, an inter-cooler is common practice, and these coolers naturally are subject to the usual cooler troubles.

On the other hand, whereas most large air compressors are horizontal units, refrigerant compressors come commonly in the vertical style. The crankcase is on the suction side of the machine, and we run into the virtues and faults of shaft seals, where the shaft enters and leaves the crankcase. Although keeping shaft seals tight is sometimes a chore, owing to any slight lack of trueness in the shaft, the defect is not a serious one, unless we end up by having to buy a new crankshaft. A little machining, or some straightening, usually is all that is involved. However, it is always a good idea to find out if shaft seal trouble has been present, for how long, and what has been done, if anything, to correct it.

Valves and bearings always need some maintenance, sooner or later. If the unit has not been overhauled recently, there is only one thing for us to do: we must add something to the purchase price to cover the work that is sure to develop. Even if the compressor has been running beautifully for its other owner, we can be sure it will demand a share of the purchase price from us, as compensation for inconveniences we have made it endure as part of the transfer. Even machinery these days shows temperament.

Heaters and Evaporators

In equipment of this sort, handling hot water and sometimes deaerating the stuff, corrosion quietly nibbles away all the time. Operators are always surprised to discover how far corrosion has eaten into metal, when ultimately they see it for the first time. Baffles and plates seem sometimes to be actually dissolving, and shells show up with near perforations, especially in the joints. Tubes as a rule hold their lusty strength longer than any other part of the unit.

If we are offered a heater, or an evaporator, we will ask immediately about its hours of service. If these hours are long, we should give up the idea, or figure an overhaul up to 50% of the purchase price.

The Kleinschmidt vapor compression still will perhaps be among those evaporators offered. This unit was a war secret. Evaporation in this design is started with electric immersion heating elements, the vapor is picked up by a rotary compressor, and then pumped thereby through a condensing coil located in the raw water entering the unit. The raw water is heated by the condensing vapor, the heat being composed of the latent heat of evaporation, plus the heat of compres-

sion. Some folks figured the heat released by the condensing vapor would be enough to create more vapor, and then the electric elements could be turned off, once the unit was running. The heat added by the compressor took the idea out of the perpetual motion class.

In practice, this still failed to operate without some of the electric heaters assisting in the evaporation. Usually, about half the electric elements were continued in service while the still was busy producing fresh water.

Vapor compression stills fall off in their output if the compressor wears beyond certain tolerances. The coils, too, are subject to the usual scaling that plagues all evaporators, and if this scale has been knocked off with mallets, the coils might be kinked and leaking.

If we are thinking about the purchase of a used still, we will find out how many hours of use the machine has completed, in order to estimate the likelihood of having to buy new rotors for the compressor. Then we will find out if the scale has been removed by acid cleaning, as recommended by the manufacturer, or if some Goliath swept it out with a mallet.

Vapor stills did a magnificent job on fighting ships during the war. If we want one to do as good for us, we will set aside enough repair and overhaul money to put it in good shape from the start.

Diesel Engines

If a diesel engine's history shows a crankcase explosion, if the operator remembers a "puff or two," and if the cylinders have not been opened since these occurrences, then we must begin to think about new rings, and scored liners, and such expensive items.

The mechanical ailments of a diesel are akin to those of a steam engine. Liners must be removed or rebored if their glassy surfaces are marred by gouges, or are out of line. The babbitt of their bearings cracks and wipes out, and they certainly get themselves out of alignment.

Misalignment ofttimes shows up in the bearings. If we find that some particular bearing is failing more often than others, we look first for inadequate lubrication, and next for misalignment. Perhaps the bearing material is of the wrong composition.

In buying a used diesel, we are concerned with estimating the imminence and extent of repairs, or an overhaul. Diesels have run for a solid year, 8,760 hours without a stop and without any evidence of serious wear. With others it was found necessary to shut down every 300 or 400 hours for bearing renewals.

If the engine we are considering has run a long time without any particular repairs, we certainly can anticipate the need for an overhaul. If it is one of the bearing troubled beauties, we likewise can fear the worst. However some engines with such a record have achieved long life and contented bearings just by changing the bearing metal.

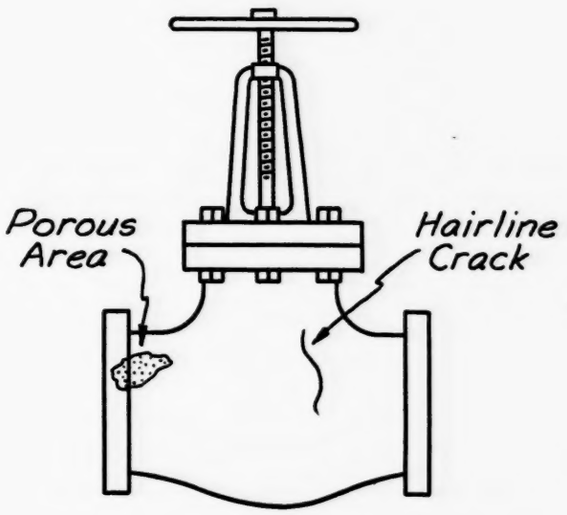
The only thing that will keep us from adding an overhaul percentage to the price of a used diesel, will be evidence of a complete and recent job of similar nature.

Valves and Fittings

Valves and fittings of large size, or for high pressures, or for some special service, cost money. Nevertheless, used units at half the price of new ones can be very poor buys if the valves turn out to be so scored across their seats that tight closures are impossible, and fittings are not much good at any price if they are porous in non-weldable areas or are of non-weldable material.

Repairs frequently involve pre-heating, machining, annealing, even the manufacture of new parts. These are costly operations and must be added to the price paid for the valve or fitting.

How can we guard against buying porosity or hairline cracks? We can choose any one of three ways. First, we can test the unit under the temperatures



Valve with porous area and hairline crack.

and pressures for which it is intended. Hydrostatic tests of steam valves are not always conclusive. On occasion, a valve that tested perfectly on water will leak through the body when subjected to the steam conditions of its normal rating. We can magnaflux the unit or employ the radiograph.

Any of these operations will create a bill that we must pay, but if we intend to be sure of what we are getting for an important service, we will accept the charge and call it insurance.

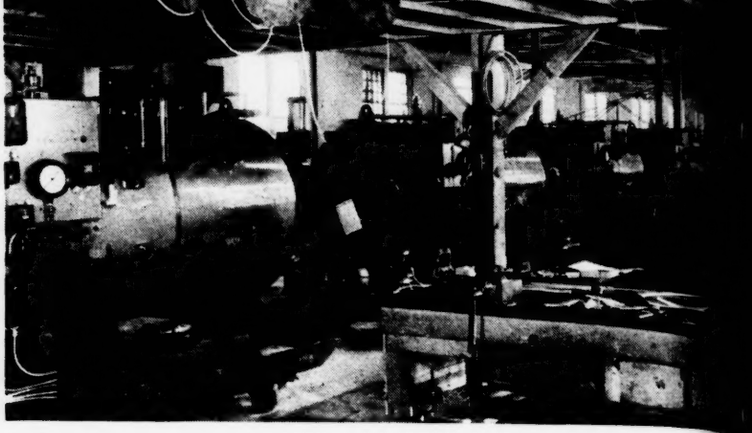
The Overall View

The asking price for any piece of used equipment does not cover the entire outlay by the purchaser. To this must be added inspection and handling costs, shipping, insurance, the charges for immediate repairs or imminent maintenance, both visible and invisible.

There is also the possibility of approaching obsolescence and perhaps the need for a compromise in size, material or efficiency.

If we can add the value of all these considerations to the purchase price and still have something that looks economically desirable, we had better go ahead with the purchase.

We've probably got a good buy.



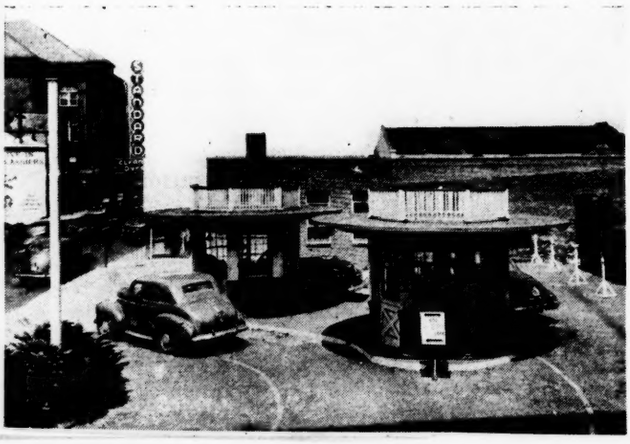
(Above) Assembly line procedure is being employed by York-Shipley, Inc., in the production of Steam-Pak generators. The photograph shows a group of 30 hp generators being assembled. After manufacture is complete, the generators are tested for 24 hours and then painted as the last operation. Generators are mounted on dollies to ease their handling during manufacture.

(Left) Installing linings of Fiberglas insulating blankets in the cabin of a PCA Capitaliner. 780 sq ft of blankets weigh 140 lb and pick up a minimum of moisture. Average diameter of glass fibers in blanket is .00005 in.

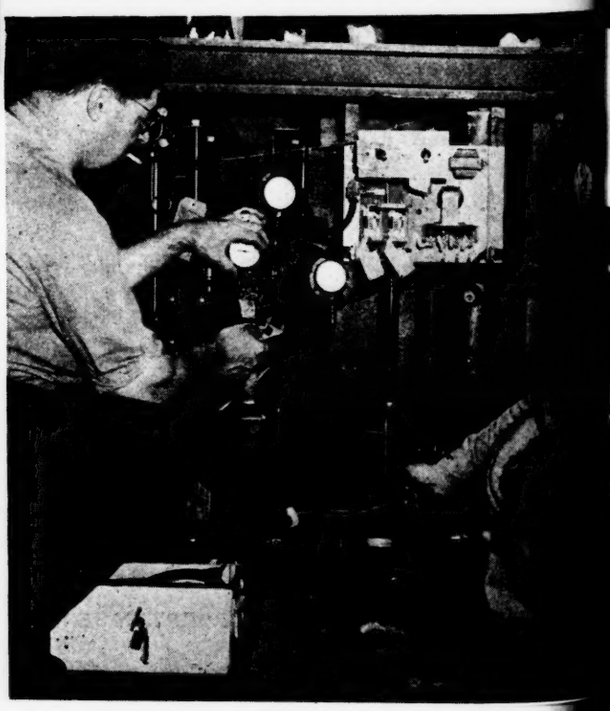
Picture Paragraphs

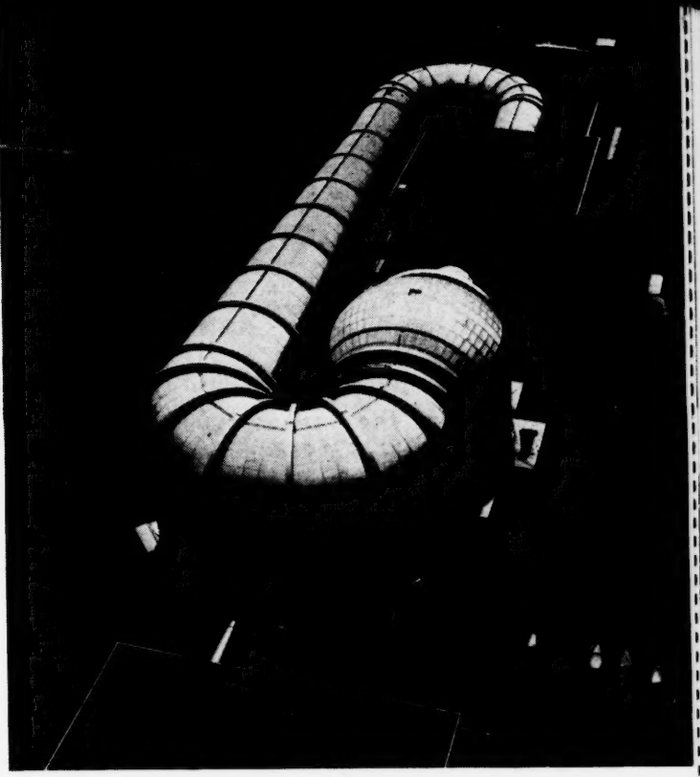
(Left) President Alfred J. Offner of ASHVE presents an engraved silver platter to society secretary, A. V. Hutchinson, at the headquarters office in recognition of Mr. Hutchinson's 20 years of service as national secretary of the organization. Left to right: Carl H. Flink, technical secretary; Walter L. Fleischer, president—1941; Mr. Hutchinson; Mr. Offner; R. H. Carpenter, Council—1930-1935; Harold J. Ryan, president of New York Chapter.

(Below) Electrically heated drive-in pay booths of United Illuminating Co. of New Haven, Conn., are heated by blower type electric unit heaters and have Dutch sliding panels to keep winter exposure at a minimum. Customers need not leave cars to pay bills.

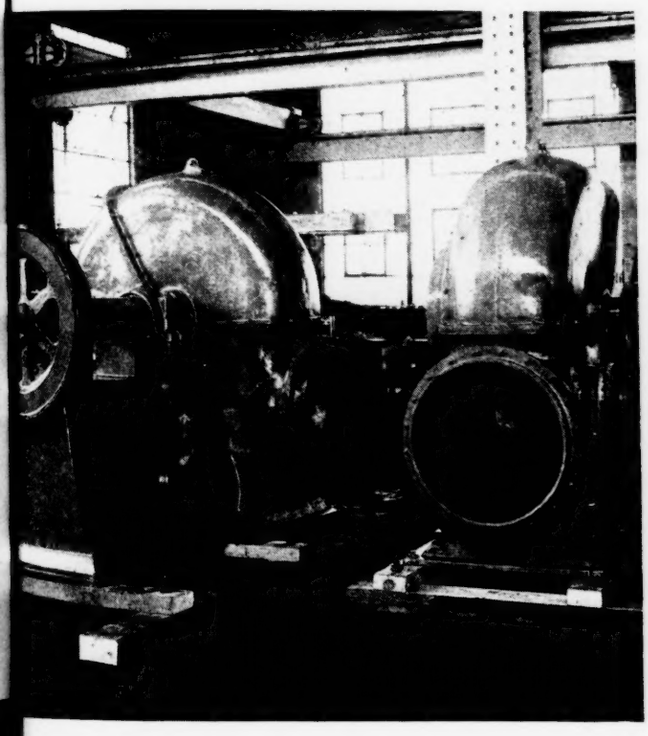


(Right) Delicate parts of the "deep water" atom bomb dropped at Bikini were guarded by 12 Chrysler Airtemp air conditioners. Same units guarded earlier A-bomb. Constant temperature control in laboratories was vital to insure success and safety. Workmen are shown installing one of units.





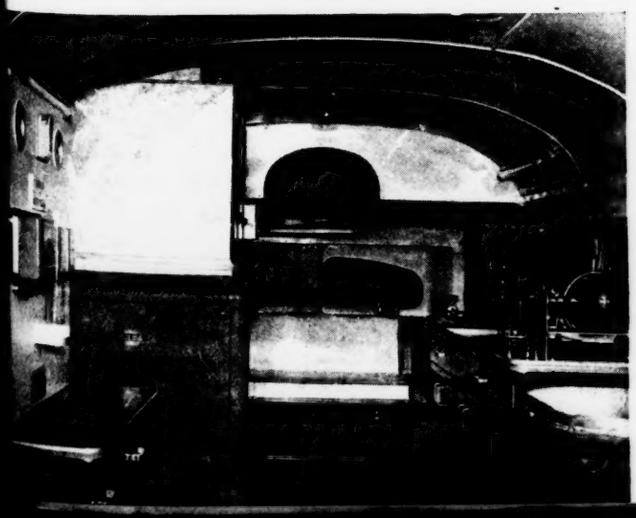
(Above) Giant fins guide air in U-turns of a new 12 ft. low turbulence pressure tunnel for airplane model testing, (right) built by Pittsburgh-Des Moines Steel Co. at Ames Aeronautical Laboratory, Moffett Field, Calif., west coast research station of the National Advisory Committee for Aeronautics.



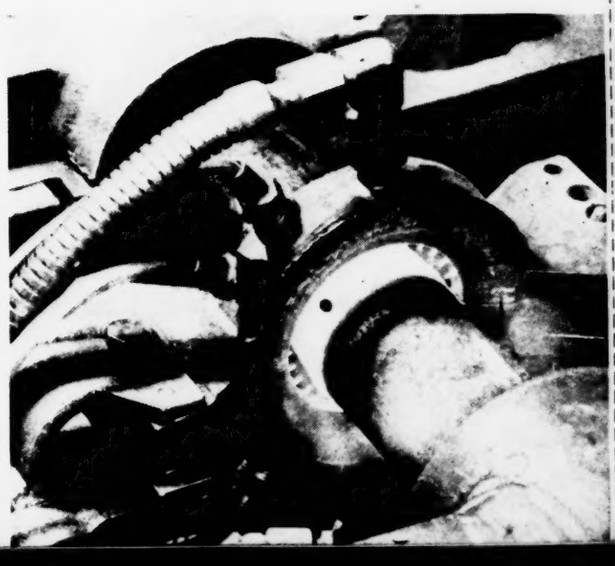
(Above) Large fans with cast lead housings and lead covered impellers made by U. S. Pipe and Foundry Co. for use in handling highly corrosive gases and vapors.

(Above) Christened "Typhoon" after the brand name of its ventilating products, a two-seater airplane purchased by Ice Air Conditioning Co., Inc., will be flown by Ice Air Vice-president Edward L. Garfield to hasten dealer service.

(Below) Tailor-made boiler tubing lengths are butt-welded under pressure with special oxy-acetylene head and hydraulic clamp. Linde photo shows beginning of plastic upsetting.



(Left) Interior of Delco-Heat mobile service trainer which looks like a bus from the outside and which delivered instruction meetings to 638 dealers in 6 months.



Industrial Unit Ventilators

J. E. YORK

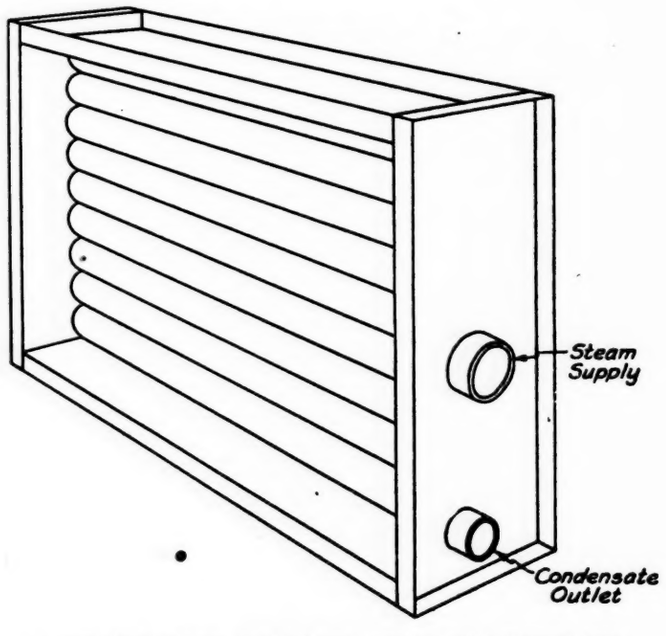
Building Service Engineer, Stone & Webster Engineering Corp.

Discussion of the various types of industrial unit ventilators, including design calculations, construction features, temperature control, and specifications.

IT is standard practice when making heating computations for buildings, not only to compute the heat transfer through all surfaces exposed on the outside to temperatures lower than in the space to be heated, but also to include additional heat for raising the temperature of the air which may be expected to leak into the building through cracks around windows and doors, or through imperfections in the building structure.

Arbitrary allowances for this purpose are based on the cubic contents of a room and its location in the building, or on the amount of crack around the doors and windows. These allowances are made for areas in which there is no necessity for providing fresh air for the health and comfort of the occupants, or for replacing air which must be exhausted to remove obnoxious fumes, dust, odors or excessive heat that may be liberated over a limited area in the enclosed space.

To heat this air which enters the room by normal leakage or infiltration, it is customary to increase the capacity of the installed heating surface to offset the heat transfer through exposed wall surfaces. It is assumed that the room air and the air of infiltration will be sufficiently mixed to provide uniform temperatures through the area. While in most cases this is a reasonably accurate assumption, we know from experience that it is not always the case, and that if windows or doors do not fit tightly, a person seated near them may be very uncomfortable.



Combined steam and return header with finned type heating surface.

Where larger quantities of air must be supplied than can enter by normal infiltration, it is evident that if comfortable conditions are to be maintained, it is necessary to preheat this air to approximately room temperature before it is delivered to the room.

Therefore a building with several separate areas to be heated and supplied with fresh air may be equipped with a central supply system consisting of fresh air intake louvers, air intake housing, heating surface, fan and distributing duct work and grilles. It may also be desirable to provide filters for air washers for cleaning the air and for adding moisture to maintain the proper relative humidity.

Also, an automatic control system will probably be required to prevent too much fluctuation in the air temperature due to changing outside temperatures.

For single rooms or buildings, without basements or other suitable space for installation of the equipment required for a central system, it is desirable to introduce the air directly to the room. This is generally done by installing unit heaters with connections on the inlet side to the outside air. Unit heaters installed in this manner are commonly called unit ventilators.

Types of Unit Ventilators

Unit heaters may be grouped into three types:

(1) Standard propeller type unit with horizontal air stream.

(2) Projection type with vertical downward air stream.

(3) Blower type.

Types 1 and 2 are equipped with propeller type fans designed for operation against limited resistance. They are not, therefore, generally considered suitable for use as unit ventilators because the combined resistance is too high for the fans. This includes resistance through the air filters, the coil surface required for heating the outside air from zero or subzero temperatures to room temperature, and in some cases the duct work required for delivery of air to suitable locations.

Type 3 unit heaters are equipped with housed type centrifugal fans which can be selected to operate against the resistances due to filters, coils and duct work. For this reason unit ventilators for normal industrial type installations are adaptations of this type of unit heater.

For use in schoolrooms, and other places of public assembly, where aesthetic considerations are of equal

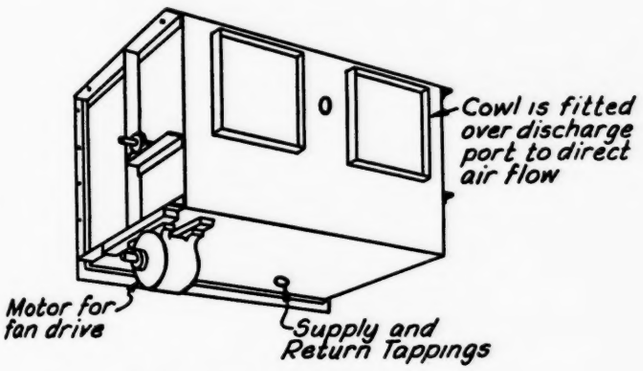
importance to utilitarian requirements, the special form of type 3 unit heaters may be installed. This type of unit was originally designed for installation in school buildings and is therefore frequently referred to as a schoolroom unit.

Construction of Industrial Type

Industrial type unit ventilators are similar in construction to type 3 unit heaters, with modifications to suit the following changes in operating conditions:

(1) A unit ventilator must deliver constantly the same amount of air during its period of operation. The fan must therefore run continuously and, as there may be a considerable variation in the temperature of the air supplied from outdoors to the heating surface, some means should be provided for automatically controlling the air temperature leaving the unit.

(2) Air which is continuously supplied to the unit from outdoors usually contains an appreciable amount



Industrial type unit ventilator with two discharge ports.

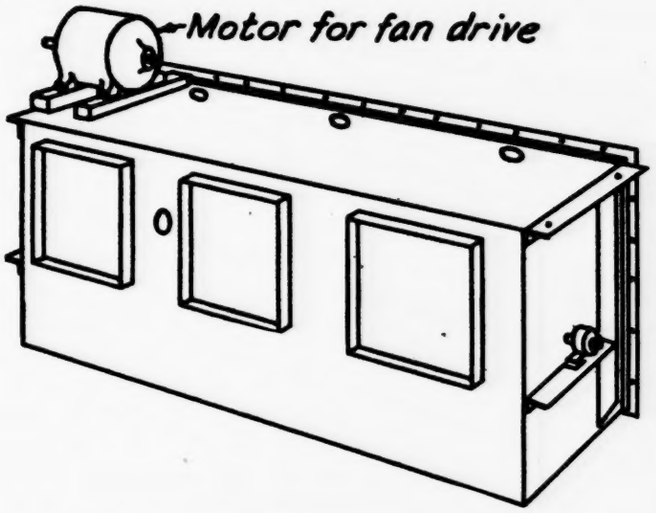
of dirt. Therefore, it is generally necessary to provide filters.

(3) The cold air from outdoors usually contains very little moisture and when heated to room temperature has a relative humidity that is too low for the health and comfort of the occupants. It will have a tendency to dry excessively woodwork and room contents. Moisture should therefore be automatically supplied to the air leaving the unit in sufficient quantity to maintain proper relative humidity in the space to be ventilated.

Heating Surface

The prime heating surface for a unit ventilator should preferably consist of nonferrous tubing with secondary surface in the form of fins having a high rate of heat conductivity. Fins are securely bonded to the prime surface to insure maximum heat transfer as described for unit heaters. Sufficient primary and secondary surface should be provided to heat the air entering the unit to approximately room temperature even during the coldest weather.

Air passing through the heating surface should be uniformly heated over the entire face of the unit. The heating surface should offer minimum resistance to the air flow and should be easily cleaned.



Unit ventilator with motor mounted on top of cabinet.

Where outside temperatures below freezing are common during the heating season, the heating surface should be of a type that will prevent cooling of the condensate to a point at which it will freeze.

The variation in final temperatures and the corresponding variation in steam consumption passing through finned type surface by changing the fin spacing are shown in Tables 1 to 3.

With the same steam pressures, and the same inlet and outlet temperatures, it is apparent that higher face velocities may be used with closer spacing of fins. The use of higher face velocities permits a more compact heating unit and a smaller casing. However, resistance to air flow will be greater and a more powerful motor will be required.

The cost of the more compact heating surface may not be any less than the larger unit which has less fins per inch of tubing. The unit with closer fin spacing will also be harder to keep clean.

Tables 1 to 3 also show that with outside temperatures as low as —20F, it generally is not necessary to provide more than two rows of tubes. With fin spacing of about four per inch (Table 2), it should be possible to use face velocities of 500 to 600 fpm through the heating surface.

Automatic Control

To maintain uniform temperature of the air leaving the unit ventilator, either a by-pass or face and by-pass dampers may be provided. Control may be accomplished by automatically varying the proportions of air by-passed and the amount passing through the heating surface, or the steam supply may be controlled by a modulating valve which closes by steps as the air temperature tends to rise. Advantages and disadvantages of these two types of automatic control will now be discussed.

By-Pass and Dampers

The by-pass may be built into the unit or may be arranged with an external duct. In either case both face and by-pass dampers should be provided and they

Tables for Variation of Face Temperature and Steam Consumption with Different Fin Spacings

Table 1 — 5 Pounds Steam; 227F; 3 Fins Per Inch

Ent. Air Temp., F	Units Deep	Velocity of Air Through Net Face Area In Feet per Minute at 70 F and 29.92 In. Barometer											
		300		400		500		600		700		800	
		Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr
—20	1	28.0	16.2	24.0	20.0	21.0	23.0	19.0	26.2	17.0	29.0	15.0	31.2
	2	66.0	29.0	61.0	36.5	56.0	43.0	51.0	48.0	48.0	53.9	45.0	58.6
—10	1	34.9	15.2	31.7	18.8	29.6	22.4	27.5	25.5	25.5	28.1	23.4	30.2
	2	72.4	27.9	67.2	34.9	62.0	40.6	58.9	46.6	55.7	52.0	53.6	57.6
0	1	43.0	14.5	40.0	18.0	38.0	21.2	36.0	24.2	34.0	26.6	32.0	29.0
	2	79.0	26.6	74.0	33.4	69.0	39.0	66.0	44.5	63.0	49.6	61.0	55.0
+10	1	51.1	13.9	48.2	17.2	46.3	20.5	44.4	23.3	42.5	25.7	40.6	27.7
	2	85.5	25.6	80.7	32.0	75.9	37.2	73.1	42.9	70.2	47.6	68.3	52.8

Table 2 — 5 Pounds Steam; 227F; 4 Fins Per Inch

Ent. Air Temp., F	Units Deep	Velocity of Air Through Net Face Area In Feet per Minute at 70 F and 29.92 In. Barometer											
		300		400		500		600		700		800	
		Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr
—20	1	43.0	21.4	40.0	27.1	36.0	31.7	34.0	36.6	32.0	41.1	30.0	45.2
	2	90.0	37.3	85.0	47.5	80.0	56.6	76.0	65.1	72.0	72.9	69.0	80.5
—10	1	51.6	20.9	47.5	26.0	44.3	30.7	42.2	35.4	40.1	39.6	38.0	43.4
	2	96.5	36.2	90.3	45.4	86.2	54.5	82.0	62.5	78.9	70.4	75.8	77.5
0	1	59.0	20.0	55.0	24.9	52.0	29.4	50.0	33.9	48.0	38.0	46.0	41.6
	2	102.0	34.6	96.0	43.4	92.0	52.0	88.0	59.7	85.0	67.3	82.0	74.1
+10	1	66.5	19.2	62.6	23.8	59.8	28.2	57.9	32.5	56.0	36.4	54.0	39.8
	2	107.6	33.1	102.0	41.6	98.0	49.8	94.3	57.1	91.4	64.5	88.5	71.0

Table 3 — 5 Pounds Steam; 227F; 7 Fins Per Inch

Ent. Air Temp., F	Units Deep	Velocity of Air Through Net Face Area In Feet per Minute at 70 F and 29.92 In. Barometer											
		300		400		500		600		700		800	
		Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr	Face Temp., F	Steam Condensate, Lb per Hr
—20	1	86.6	36.2	75.6	43.2	68.2	49.9	62.0	55.6	57.3	61.2	53.5	66.4
	2	147.3	56.8	134.0	69.6	125.0	82.0	116.9	92.9	110.3	103.1	105.3	113.1
—10	1	92.3	34.7	81.7	41.5	74.6	47.9	68.7	53.4	64.2	58.7	60.6	63.7
	2	150.7	54.5	137.9	66.9	129.0	78.6	121.3	89.2	115.0	99.0	110.3	108.7
0	1	98.0	33.2	87.8	39.7	81.0	45.8	75.3	51.1	71.0	56.2	67.6	61.1
	2	153.7	52.2	141.6	64.0	133.1	75.4	125.7	85.4	119.8	94.8	115.1	104.0
+10	1	103.6	31.8	94.0	38.0	87.4	43.8	82.0	48.9	77.8	53.7	74.6	58.4
	2	157.0	49.8	145.2	61.2	137.1	72.0	130.0	81.5	124.5	90.7	120.0	99.4

should be mechanically interlocked to proportion the air flow between the heating surface and the by-pass.

Normally, the by-pass will be much smaller than the face area of the heating surface. One method for determining the by-pass size is to make it of such area that if all of the air were passed through it, the velocity pressure necessary for this would be equal to the pressure drop through the heating surface when all the air is passing through it.

Unit ventilators for industrial installations are usually the draw-through type. Air is drawn through the heating element or by-pass to the fan inlet which provides better mixing and tends to reduce stratification.

With face and by-pass dampers, the full steam pressure is usually maintained in the unit. This reduces stresses caused by change in heating surface temperature.

Example of By-Pass

The following example will illustrate the result of by-passing a part of the air because of a temperature rise of the outside air.

It will be assumed that the unit has heating surface with four fins per inch and that it is designed for a face velocity of 500 fpm when the outside temperature is —20F and all air is passing through the heating surface. The heating surface is two rows deep and the air leaves the unit at 80F. The condensation rate under these conditions is 56.6 lb per hr per sq ft of face area.

If the outside air temperature rises to 0F, only 80% of the original heating will be required or 45.28 lb of condensate per hour. If 20% of the air is by-passed, the velocity of the remaining air through the heating surface will be reduced to 400 fpm (500×0.80); air passing through the unit will leave at a temperature of 96.0F, but when mixed with 20% outside air at 0F the resultant temperature will be 76.8F.

The condensate rate for 400 fpm shown in Table 2 is 43.4 lb per hour which provides a reasonably close check.

Theoretically, the control of the leaving air temperature by means of face and by-pass dampers is a satisfactory method for maintaining a uniform predetermined temperature of the air leaving the unit. Actually, however, with a reduced quantity of air passing through the heating element there may be a tendency toward uneven distribution of the air over the face of the heating section. This sometimes results in stratification and puffs of air at varying temperatures.

Temperature Control by a Modulating Valve

An alternate method for controlling the temperature of the air leaving the unit is by varying the steam pressure supplied to the heating surface.

Table 5 gives factors for determining the effect of variation of steam pressure on capacities of heating surface and the air temperature leaving the heating surface.

In the example given under "By-pass and Dampers," if a modulating valve were used on the steam supply and the by-pass omitted, a study of the table will show that with the steam pressure reduced from 5 to 0 lb and outside air at 0F, the heating effect would be .933 ÷ 1.088, or approximately 86% of the original amount.

It would, therefore, be necessary to throttle the steam supply to a point below atmospheric pressure to maintain the original temperature of the air leaving the unit.

Nonfreeze Surface

With the steam pressure inside the heating surface at or below atmospheric pressure, there will be a tendency for the condensate to be held back in the heating surface a sufficient length of time for it to cool to the freezing temperature. Ice will gradually form near the return outlet and may build up to a point where it will rupture the heating surface.

To eliminate this danger and to provide even heating of the air over the entire face of the unit, a special form of heating surface commonly known as "nonfreeze type" is used in some of the better makes of unit ventilators.

This surface, as shown in Fig. 1, consists of a combined steam and return header with finned type heating surface attached to the return side of this header at one end and the tubes individually capped at the other end. A tube of small diameter is run from the supply side of the combined header, through the return side, and the full length of each finned type tube. This smaller tube has perforations for the full length of the outer tube which permits steam to enter at approximately uniform pressure over the entire surface and prevents any cold spots which would cause uneven heating of the air and possible freezing of the condensate.

Auxiliary strainers are generally provided in the steam supply to the unit to prevent particles of scale plugging the perforations in the inner tubing.

Filters

There are several varieties of filters available for use in unit ventilators. The so-called dry type, consisting of steel wool or fiber glass in a cardboard casing, will not burn or give off smoke and can be readily handled or stored conveniently. Because there is no viscous coating, the filter pads are easily cleaned and are therefore more likely to be properly maintained. Some forms of dry type filters have refill units which are of sufficiently low cost to permit replacement with new units, thus eliminating all cleaning.

Humidifier

Steam jets in the heated air stream from the unit ventilator provide a simple means for humidification of the air because the valve on the supply line may be readily controlled by means of a humidistat located in

the room, but this arrangement is often objectionable because of odors given off by steam from ordinary boilers.

An alternate method is to provide a shallow pan with a float controlled valve to maintain a constant water level. A steam coil is provided in the bottom of the pan and the valve on the steam supply to this coil is controlled by the room humidistat. When the desired relative humidity in the room is reached, the valve on the steam supply line is closed, thus reducing the heat supplied to the water in the pan and consequently the rate of evaporation.

Example of an Installation

The following example illustrates the use of a unit ventilator in an industrial building where objectionable odors and vapors are given off by equipment. A brief outline is given of a specification for the purchase of such a unit.

In this building there are six filter presses which must be steamed out to clean them at regular intervals. During the cleaning out process, odors given off are very objectionable and hoods are installed over the presses. These hoods are connected through duct work

Table 4 — Friction of Air in Inches of Water for 70F Air

Number of Sections Deep	Velocity of Air in Feet per Minute Through Face Area					
	300	400	500	600	700	800
	3 Fins Per Inch					
1	.021	.036	.055	.079	.106	.137
2	.037	.065	.100	.144	.194	.251
	4 Fins Per Inch					
1	.048	.081	.124	.174	.236	.305
2	.076	.130	.200	.282	.380	.490
	7 Fins Per Inch					
1	.100	.170	.258	.363	.485	.620
2	.180	.308	.468	.660	.878	1.120

to an exhaust fan on the roof. Two presses are steamed out at one time and, during this time, the other four hoods are in operation. During the steaming out process it is necessary to exhaust 4,000 cfm of air per hood over the presses being cleaned and 1,000 cfm of air for each of the other hoods, making a total of 12,000 cfm.

Specification for Industrial Type Unit

To offset the removal of this air from the room it is necessary to supply an equal amount of fresh air which must be heated from the minimum outside temperature of —10F to room temperature of 65F.

Following is a brief specification of the equipment to be furnished.

To provide make-up air in the filter press room, two unit ventilators shall be furnished.

Each unit ventilator shall have a capacity of 6,000 cfm of air to be heated from —10F to +65F with steam at 5 lb gage pressure.

Each unit shall be of the overhead horizontally suspended type with fans, V-belt drive, motor, heating surface, filter, and face and by-pass dampers for temperature regulation. Provision shall be made for 100% recirculation of room air for heating the building during shutdown periods.

Table 5 — Constants for Obtaining Temperature Rise at Various Steam Pressures and Entering Air Temperatures Not Shown in Tables

Enter. Air Temp., F	Steam Pressure In Lb per Sq In. (Gauge)				
	0	2	5	10	15
—20	1.021	1.050	1.088	1.142	1.187
—10	.977	1.006	1.044	1.098	1.143
0	.933	.962	1.000	1.054	1.100
10	.889	.918	.956	1.010	1.055
20	.845	.874	.912	.966	1.012
30	.801	.830	.868	.922	.968
40	.757	.786	.824	.877	.923
45	.735	.764	.802	.856	.901
50	.713	.742	.780	.834	.879

Note: To obtain final temperature for steam pressures or entering air temperatures other than those shown in tables, multiply the ratings for zero entering air temperatures and 5 pounds steam pressure as shown in the various tables, by conversion factors given in this table, and add this temperature rise to temperature of entering air.

Fans shall be of the housed centrifugal type with forward curved blades, designed for operation without duct work from the discharge outlets.

Rotors for the fans shall be mounted on a common shaft of cold rolled steel and shall be driven through a V-belt by a motor of ample capacity for the maximum output of the fans. Motors shall be in accordance with the latest standards of the AIEE and shall be wound for 440-volt, 3-phase, 60-cycle alternating current.

Heating surface shall be nonferrous finned tubing of the nonfreeze type suitable for a maximum working steam pressure of 125 lb per sq in.

Filters shall be of the dry type arranged for easy access for inspection and replacement. Replacement units shall have cardboard casings with fiber glass or steel wool filler.

For controlling the temperature of the air leaving the unit an external type by-pass, and face and by-pass dampers shall be provided. An additional damper for shutting off the outside air and providing for 100% recirculation of room air shall be furnished on the inlet side of the heater for use when warming up the building during the shutdown periods.

The casing shall be rigidly constructed of No. 16 gage steel plate and the unit shall be provided with steel hangers from the ceiling overhead.

Cold Water Piping in Industrial Plants

Part 2: Comparison of Flow Formulas

HARRY D. UNWIN
Mechanical Engineer, Albert Kahn Associated Architects and Engineers, Inc.

In this, the second of a four-part series of articles on industrial cold water piping, the author presents the various formulas for the constant C in velocity equations, friction loss factors, and a discussion of Reynolds' findings regarding viscous and turbulent flow. While the data were specifically assembled for industrial plant piping, it applies to any cold water piping system.

THE determination of the flow either in open channels or in pipes is based upon $Q = AV$. Since the area A is either known or assumed, the value of the velocity V for uniform flow is the unknown quantity. It may be reasoned that in fluid flow problems in pipes running full that $V = \frac{Q}{A}$, a fact that cannot be refuted, but V is a function of many variables depending upon experimental data so that this factor has been and still is a subject of great controversy. Ever since the day when Chezy proposed his now famous relationship of $V = C R^{1/2} s^{1/2}$ for the uniform flow of water in conduits, eminent hydraulicians have sought the true value of the constant C, some of whose equations are as follows:

Chezy $$V = C R^{1/2} s^{1/2}$$

Kutter $$V = \left[\frac{41.6 + \frac{1.811}{n} + \frac{0.00281}{s}}{1 + \frac{n}{\sqrt{R}}\left(41.6 + \frac{0.00281}{s}\right)} \right] R^{1/2} s^{1/2}$$

Manning $$V = \left(\frac{1.486\, R^{1/6}}{n}\right) R^{1/2} s^{1/2}$$

Schoder $$V = 175\ R^{0.67}\ s^{0.57}$$

Williams and Hazen $$V = 1.32\ C\ R^{0.63}\ s^{0.54}$$

where V = average or mean velocity across the entire cross-section area in feet per second,

R = hydraulic radius in feet,

s = sine of the angle of slope of the energy gradient or loss of head divided by the length of pipe. Since head and length are both lineal dimensions, s is a pure number.

C = coefficient, and

n = a number representing the coefficient of roughness or surface condition of the pipe.

The Kutter formula is cumbersome and requires extensive computation and tables for n as a result of which various charts have been prepared to simplify this procedure. Nevertheless, it is one of the most widely used formulas for the flow in open channels. In general the C in the Chezy formula is approximately 100 as determined for Kutter's factor n for medium roughness. This factor varies from 0.010 for very smooth steel and cast iron pipe to 0.015 for old pipe in poor condition, an average value of 0.012 being generally used.

The Manning formula, like that of Kutter, is based fundamentally upon the ancient Chezy formula but contains a much simplified expression for the coefficient C. When written $V = \frac{1.486}{n} R^{2/3} s^{1/2}$ it is only necessary to know the value of n which is the same roughness factor used in the Kutter formula.

A few years after Manning developed his equation, Schoder carried on experimental work on the flow in pipes and as a result subdivided flows into four groups based upon the surface condition; namely, (1) extremely smooth; (2) fairly smooth; (3) rough pipes; and (4) extremely rough pipes. In each case, he revalued the coefficient C and the exponents of R and s, the change being an increase of all factors as the surface condition became rougher; the terms of the equations remaining the same as those in the Chezy formula. Whether the use of four equations is superior to a single equation with a table of factors for the roughness in different classes of pipe is open to discussion. Schoder has prepared charts for the determination of the loss of head per thousand feet due to friction which are of a similar nature to the Kutter diagrams.

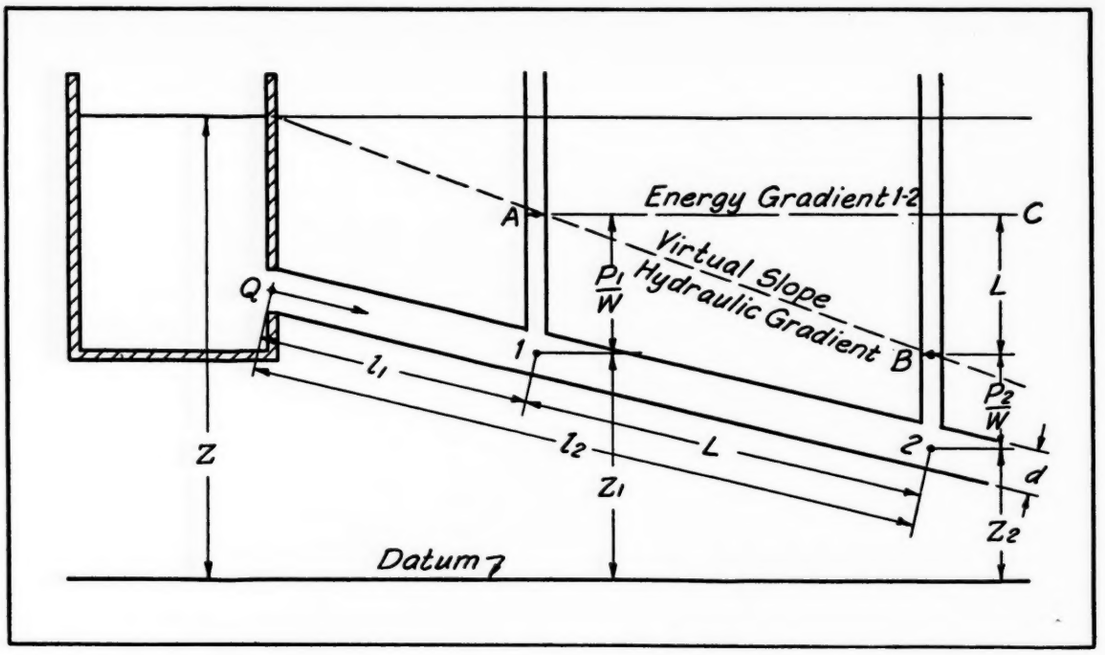


Fig. 4. Darcy-Chezy relationship for loss of head due to friction.

About the same time that Schoder brought forth his version of the Chezy formula, Williams and Hazen made their study of the mass of experimental data that had accumulated and determined that if the exponents of R and s could be perfectly deduced, then the coefficient C, which is a function of the roughness of the pipe, would be a constant. Consequently, they added a factor $(0.001)^{-0.04}$ to the Chezy formula and revalued the exponents in order to bring the equation into alignment with the best possible average conditions of experiments upon the flow of water in pipes.

Friction Factor and Coefficient C

The derivation of the Chezy formula results in $C = \left(\frac{8g}{f}\right)^{\frac{1}{2}}$ and subsequent research has been an endeavor to determine a positive value for this ratio for all classes of pipe surface, with the result that the many studies have produced a variation in the interpretation of experimental data. Some believe that a broad division of surfaces is ample while others deem it necessary to set up tables based upon a much finer distinction between "smooth" and "rough" surfaces. For long pipe lines, say 3000 to 10,000 ft, it is quite evident that a small error in the friction factor will produce a cumulative error in the final result of such magnitude that the size of pipe as computed from the inaccurate data will be entirely inadequate or exceedingly oversized. Therefore, it is essential, within certain limits to be further discussed, to have as accurate figures as obtainable in order to reduce the overall error to a practical and reasonable degree. With this in mind, the designer should have an understanding of the several factors which contribute to the resistance to fluid flow known as the loss of head due to friction.

A brief description of the two types of flow is necessary more clearly to judge the effect of the several factors involved. The main source of opposing force which retards fluid flow is that due to friction which results from the retardation of flow at the pipe surface, causing the particles to slide past each other with increasing rapidity as the center of the pipe is approached. At the pipe surface, the adhesiveness of the fluid produces a greater retarding force than the cohesiveness of the particles of liquid for each other, thus creating a variation in the velocity of flow across the pipe. For very low velocities, the effect of this force, which is related to and caused by the viscosity of the liquid, is less marked and this type of flow is referred to as viscous flow since the particles of liquid move along the pipe in a more or less regular or straight path such as would occur if a series of concentric tubes were sliding within each other; the smaller tube at the center traveling at a much higher rate of speed than the tube in contact with the wall of the pipe. When the average rate of flow, as determined by dividing the quantity by the area of the pipe, or velocity of the fluid has increased to what is known as the critical range, the straight, even, concentric paths of the particles of liquid no longer exist. For some reason, yet not fully known, the paths of the particles are disrupted to such an extent that a condition of turbulence is created, which is self-explanatory, in the sense that the particles have no definite path and are moving in a generally forward direction but without guidance or control. Such turbulent motion is present even in smooth pipes but is accentuated as the roughness of the surface is increased. Since the mass of liquid is actually moving along the pipe, there must still be some slipping and sliding of particle past particle of fluid; or in other words, the effect of the viscosity of the liquid is still a factor but to a considerably less degree. In very small pipes of the tubular class, it is probable that the flow of water is in the viscous range as is also true of heavy oils (high viscosity) in commercial sizes of pipe. However, in the usual sizes of pipes installed for water systems in industrial piping, the flow is

more than likely to be turbulent flow in the majority of cases.

From the basic Darcy equation, it is seen that the loss of head occasioned by fluid flow in pipes is affected by the friction factor, length, velocity and diameter. If a series of piezometer tubes are installed along a horizontal pipe of constant diameter, such as in Fig. 4, it is found that the loss of head for different sections in the pipe is proportional to the distance from the source or between open tubes.

Further evidence that this is true is observed by the fact that a line connecting the water levels in the piezometer tubes is a straight line and when such a line, known as the hydraulic gradient, is straight, the loss in head in the pipe is proportional to the length of pipe. If the loss of head is measured at different rates of flow in a particular pipe and the results plotted logarithmically, the straight lines which are obtained indicate that $h_f = k\,L\,V^n$ as seen from Fig. 5. The experimental data, resulting from the measurement of the loss of head due to friction for different velocities of flow, further show that, for the line *ab*, the loss of head varies as the first power of the velocity, hence $h_f = k_1\,L\,V^{1.0}$. For the higher velocities, the data indicate that $h_f = k_2\,L\,V^{1.7 \text{ to } 2.0}$ as shown by the line *de*. This higher power of the velocity is attributed partly to the roughness of the pipe surface and largely to the increase in the rate of flow for a given diameter of pipe. The dotted triangle represents the region where the velocity of flow is in the critical range.

In order to clarify this break in the continuity of the theory of fluid flow, Reynolds conducted experiments which definitely showed the limiting points on the log h_f/log V curve and established the fact that in a pipe of constant diameter, the conditions of viscous flow continued to point *c* along the line *ac* for an increase in velocity. At points *d* the relationship of h_f to *V* again became established and continued along the line *de* but following a different law. However, if the experiments began with high velocities and measurements for the loss of head due to friction were taken at successively lower velocities, the law of turbulent flow persisted beyond point *d* and continued to point *b*, the intersection with the line for viscous flow. The line *bd* is well-defined as the region of critical velocities because it is within this range that definite values for the loss of head are indeterminant. If the values of h_f and *V* are plotted on logarithmic cross-section paper for the flow in a series of pipes of different diameter, the lines thus obtained will have slopes of the same order for viscous and turbulent flow as indicated in Fig. 5. For any given velocity, it is evident and experimentally provable that the loss of head due to friction is definitely a function of the pipe diameter. Both theory and experimental results tend to show that the head lost due to friction, while dependent upon the size of pipe, is governed by a different law when the flow is turbulent than when it is viscous, as follows:—

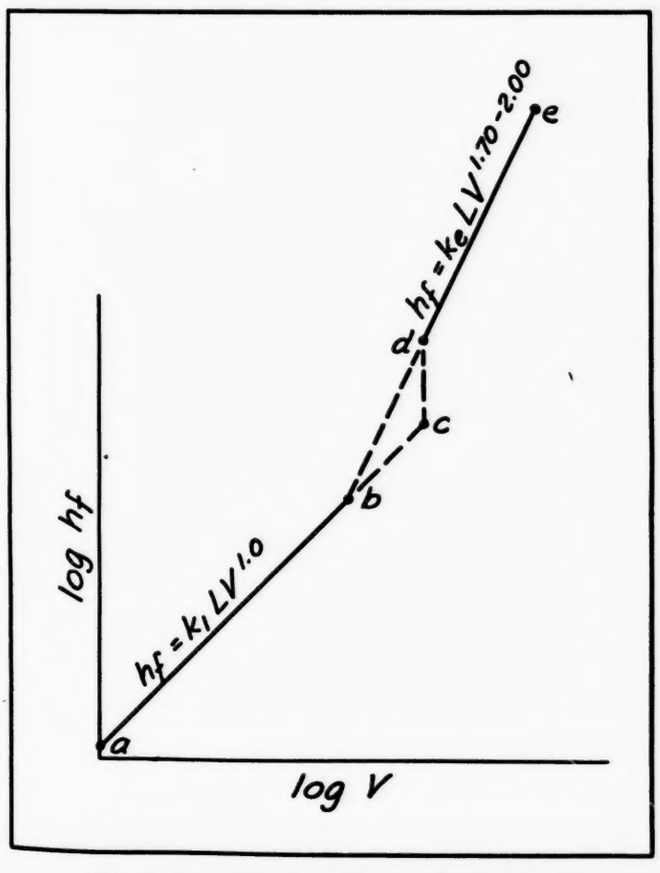


Fig. 5. Logarithmic plotting of h_f against *V*.

Viscous flow $$h_f = k_1\,L\,\frac{V}{D^2}$$

Turbulent flow $$h_f = k_2\,L\,\frac{V^{1.7 \text{ to } 2.0}}{D}$$

It is evident that under viscous flow conditions, the loss of head due to friction is inversely proportional to the square of the diameter. However, for turbulent or sinuous flow, the relationship is variable due to the effect of the condition of the pipe surface and no single value can be assigned to the exponent for *D*. The mass of experimental data on the flow of fluids in pipes indicates a variation for this exponent of 1.15 to 1.35 with an average of 1.25. Schoder and Dawson have expressed the belief that the accumulated data substantiate the claim that this average value is not only applicable to extremely smooth pipes (an undisputed fact) but may also be used for the rougher pipe surfaces.

From the definition of viscous flow, it is readily deduced that the loss of head due to friction is largely the result of the sliding or slipping of liquid particles past one another than due to the condition of the pipe surface. Experiment has proven this to be true; but on the other hand, the roughness of the surface is a very definite influence on the loss of head due to friction under turbulent flow conditions. It has also been shown by experiment that the loss of head due to friction varies as $\frac{\mu}{\rho} = v$ for viscous flow and as μ^z for turbulent flow, where μ is the absolute viscosity; ρ is the density or specific gravity; v is the kinematic viscosity; and z is an exponent whose value varies be-

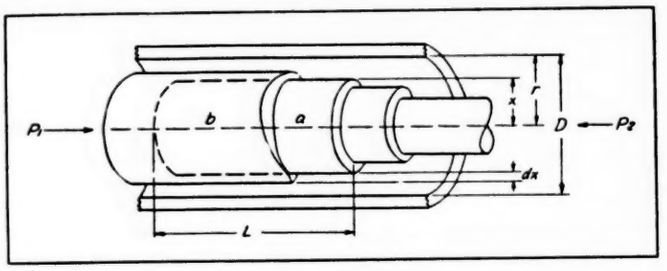


Fig. 6. Laminar or viscous flow.

tween 0.25 and 0.15. The effect of temperature on the density and therefore on the loss of head due to friction is negligible for water at normal temperatures dealt with in process water piping work in relationship to other estimated data upon which such pipe distribution systems are designed. Since water is for all practical purposes considered incompressible, the variation in the density is too small to be considered in the type of industrial piping under discussion. It is frequently stated that the resistance due to friction is independent of the pressure.

In viscous or laminar flow, the movement of particles in motion is likened to that of concentric tubes or hollow cylinders sliding past or through one another with the cylinder at the core or center moving at a faster speed than the adjacent outer layer; with each successive cylindrical lamination moving slower until the layer at pipe wall is practically static. In fact, it can be shown that the average velocity across the pipe is one-half the maximum rate of flow at the center of the pipe. Fig. 6 represents viscous, tubular, or laminar flow conditions. In order to develop the expression for loss of head due to friction for viscous and turbulent flow, assume a section or element of fluid of radius x, thickness dx, length L, having an absolute viscosity μ and moving at a relative velocity of v. The definition of viscosity states that it is the force required to overcome the resistance to motion of a layer of the liquid of unit area to another parallel layer at unit distance from the first layer and moving with unit velocity in respect to the first layer. This is known as the absolute viscosity μ, the unit of measure being the poise. The relative velocity of cylinder a to cylinder b is by definition $\frac{dv}{dx}$. The total force or resistance to shear of the entire cylinder is $2\pi x L \mu \frac{dv}{dx}$ where $2\pi x L$ is the circumferential surface of cylinder a. The net pressure available to cause flow and overcome the shearing force is the difference between the pressure exerted on the two ends of the cylinder. Hence,

$$P = p_1 \pi x^2 - p_2 \pi x^2 = (p_1 - p_2) \pi x^2$$

Equating and integrating, and noting that dv is negative

$$v_x = v_c - \frac{(p_1 - p_2)}{4 L \mu} x^2$$

For viscous flow, the velocity at the pipe wall is zero ($v_x = 0$) when $x = r$, and v_c = velocity at center of pipe. Then

$$v_c = \frac{(p_1 - p_2)}{4 L \mu} r^2$$

and for the flow through a single shell of radius x, thickness dx, and velocity v_x it can be shown that

$$Q = \frac{\pi D^4}{128 L \mu} (p_1 - p_2)$$

also

$$Q = \frac{\pi D^2}{4} V$$

where V = mean or average velocity in pipe of radius r. Equating these two expressions for Q and solving for the pressure drop $p_1 - p_2$

$$p_1 - p_2 = \frac{32 L \mu V}{D^2}$$

But

$$h_f = (p_1 - p_2) \div w$$

Hence by substitution, and since $\frac{w}{g} = \rho$,

$$f = 64 \frac{\mu}{DV\rho} = \frac{64}{R} \qquad (9)$$

where $\frac{DV\rho}{\mu}$ is the well-known expression for the

Table 1 — Critical Velocities for Cold Water in Pipes

Dia. of Pipe, Inches	Temperature, °F					
	50	60	70	80	90	100
	Density, Lb per Cu Ft					
	62.42	62.37	62.30	62.22	62.10	62.00
	Viscosity, Centipoises					
	1.4	1.2	1.0	0.9	0.8	0.7
	Critical Velocity, FPS					
¾	0.466	0.412	0.343	0.310	0.275	0.242
1	0.350	0.309	0.257	0.232	0.206	0.181
1¼	0.270	0.247	0.206	0.186	0.165	0.145
1½	0.233	0.206	0.172	0.155	0.137	0.121
2	0.175	0.155	0.128	0.116	0.103	0.091
2½	0.140	0.124	0.103	0.093	0.083	0.072
3	0.117	0.103	0.086	0.077	0.069	0.060
4	0.088	0.077	0.064	0.058	0.052	0.045
5	0.070	0.062	0.051	0.046	0.041	0.036
6	0.057	0.052	0.043	0.039	0.034	0.030
8	0.044	0.039	0.032	0.029	0.026	0.024
10	0.035	0.031	0.026	0.023	0.021	0.018
12	0.029	0.026	0.021	0.019	0.017	0.015

Reynolds number which is dimensionless. In the final equation for the friction factor f, all units are in the metric system. For the English system,

$$f = \frac{64\,\frac{\mu}{100}}{\frac{D}{0.3937}\,\frac{V}{0.0328}\,\frac{\rho}{62.4}}$$

$$f = \frac{0.512}{R} \qquad (10)$$

where μ = absolute viscosity in centipoises
D = diameter in inches
V = feet per second
ρ = density in pounds per cubic foot

$$R = 125\,\frac{D\,V\rho}{\mu}$$

Expressing the absolute viscosity in centipoises is the more normal condition in practice. However, if it is expressed in English units; therefore, lbs force sec per sq ft, then one poise equals 0.0672 English units and the value of f becomes $\frac{768}{R}$.

In turbulent flow, the relationship for expressing the head lost due to friction is dependent upon variable exponents for the velocity and diameter; the effects of viscosity and density are not constant; and the roughness of the pipe surface sets up internal fluid friction in addition to the friction at the pipe wall. Consequently, it will be seen that to develop a rational formula equating all these variables in a constant mathematical relationship is practically impossible. Therefore, all of the more familiar equations are based on experimental values for certain constants and exponents. This will be clearer if the definitions and relationships pointed out above are set down in the form of an equation.

$$h_f = X\left(\frac{\mu}{\rho}\right)^z L\,\frac{V^n}{D^m}$$

where X is a term combining the constants and roughness factor; $\frac{\mu}{\rho}$ is the Kinematic viscosity v and varies as some power z which has been stated to be about 0.25 for water in smooth pipes; and n and m are variable exponents for velocity and diameter, respectively, which experiment has shown, according to Schoder, to have values of $n = 2 - z = 1.75$ and $m = 1 + z = 1.25$. This seems logical since for dimensional continuity $n + m = 3$. If the Darcy formula (Equation 7) is equated to this relationship,

$$\text{then } f = \frac{2gX}{R^z} \qquad (11)$$

where R is the Reynolds number as in the equation for viscous flow. This indicates that for turbulent or sinuous flow, the coefficient of friction f varies directly with X, an experimentally determined variable, and inversely as some fractional power of the Reynolds number ranging from 0.25 to 0.15. If equation (11) is expressed in English units and μ is in centipoises, the same as equation (10), the relationship becomes

$$f = 0.8 \times 2g\,\frac{X}{R^z} \qquad (12)$$

Fig. 7 is a plotting of experimental data using Equation 9 for viscous flow and Equation 11 for tur-

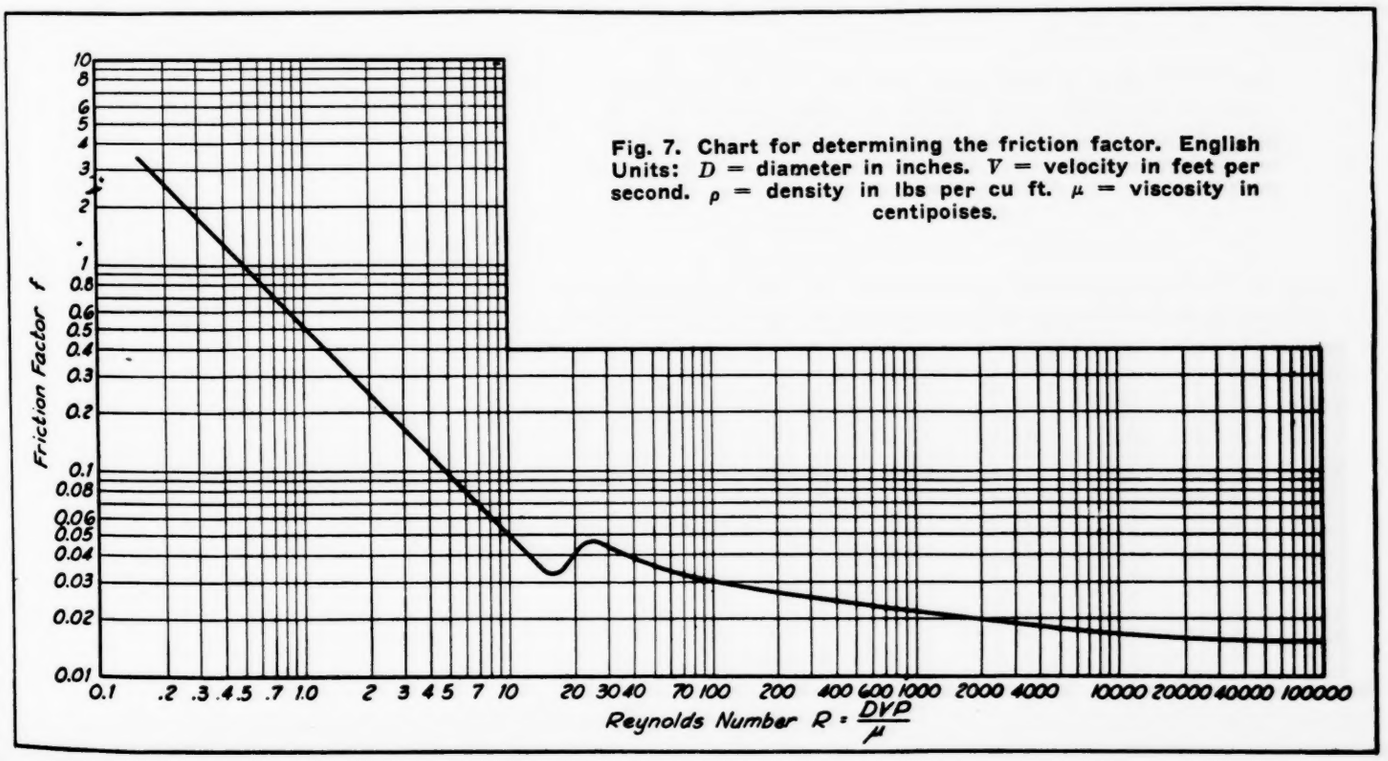


Fig. 7. Chart for determining the friction factor. English Units: D = diameter in inches. V = velocity in feet per second. ρ = density in lbs per cu ft. μ = viscosity in centipoises.

Table 2 – Friction Loss Table for Cold Water for Various Velocities

Velocity, V, Ft per Sec.	Pipe Diameter, Inches												
	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
	Friction Loss, Ft of Head per 100 Ft												
1.0	1.85	1.23	0.99	0.77	0.55	0.43	0.36	0.24	0.19	0.17	0.12	0.07	0.06
1.5	3.70	2.62	2.02	1.63	1.18	0.91	0.74	0.53	0.39	0.34	0.22	0.17	0.14
2.0	6.16	4.48	3.46	2.78	2.09	1.49	1.27	0.91	0.67	0.58	0.41	0.31	0.24
2.5	9.36	6.54	5.23	4.20	2.98	2.38	1.87	1.39	1.06	0.86	0.60	0.46	0.38
3.0	13.00	9.06	7.25	5.83	4.20	3.15	2.57	1.95	1.44	1.18	0.86	0.65	0.53
3.5	17.30	12.55	9.48	7.74	5.58	4.18	3.44	2.50	1.87	1.61	1.15	0.86	0.69
4.0	22.35	15.85	12.15	9.95	7.15	5.37	4.42	3.22	2.52	2.06	1.49	1.13	0.92
4.5	27.80	19.70	15.10	12.38	8.90	6.91	5.49	3.74	3.07	2.59	1.87	1.42	1.13
5.0	33.85	23.75	18.44	14.96	10.73	8.10	6.26	4.85	3.74	3.10	2.26	1.73	1.39
5.5	40.00	27.55	22.15	17.75	12.90	9.78	8.14	5.81	4.49	3.72	2.71	2.09	1.66
6.0	46.60	33.60	25.80	20.65	15.12	11.48	9.44	6.82	5.23	4.37	3.14	2.45	1.92
6.5	55.20	38.60	29.75	23.75	17.60	13.45	10.68	7.97	6.07	5.06	3.67	2.86	2.26
7.0	62.35	44.40	35.05	27.15	19.87	15.40	12.50	9.12	6.96	5.74	4.20	3.29	2.62
7.5	70.00	50.75	37.55	31.15	22.60	17.53	14.52	10.03	7.75	6.46	4.77	3.70	3.00
8.0	79.25	56.15	43.10	34.55	25.35	19.80	16.10	11.50	8.78	7.27	5.40	4.20	3.38
8.5	88.35	66.25	48.00	38.90	28.45	22.15	18.00	12.83	9.87	8.16	6.00	4.70	3.82
9.0	96.00	68.15	53.15	42.60	31.55	24.60	20.00	14.17	10.88	9.03	6.65	5.24	4.22
9.5	108.00	76.10	58.65	47.50	35.00	27.45	22.10	15.15	11.95	9.82	7.26	5.81	4.68
10.0	119.10	82.10	64.00	50.20	38.25	29.85	24.25	17.07	13.10	10.63	7.95	6.31	5.14

bulent flow. The abscissa scales have been shown for the English system units. Viscous flow exists when R is less than 2000 (c.g.s. units) which is equal to R = 16 in English units (Equation 10). The lower value of R which occurs at point b, Fig. 5, is of greater importance in pipe flow problems than the higher value since water invariably enters the piping system in a turbulent state. Therefore we shall consider only the lower critical velocity in the present discussion.

Since

$$R = \frac{DV\rho}{\mu} = 16$$

(English Units)

and water at 68F has an absolute viscosity of 1.0 centipoise and a density of 62.3 lb per cu ft, then

$$\text{Lower critical velocity } V = \frac{16 \times 1.0}{62.3 \times D} = \frac{0.257}{D}$$

where D = diameter in inches

V = velocity in feet per second.

Since cold water piping in industrial plants is usually found to be at temperatures of 50F to 100F where used for process work and in air conditioning systems, the values in Table 1 for the critical velocities in pipes of various diameters are confined to this temperature range. For obvious reasons, lower temperatures such as those occurring in refrigerating work are purposely omitted as being beyond the scope of this article. It is apparent from this tabulation that the viscosity is very important, even for normal temperatures, and that the critical velocity is directly proportional to the absolute viscosity. The effect of temperature on the density of water within this range is minor and can be neglected since an error of less than 1.0% would occur if 62.42 were used instead of 62.00 for 100F, and in most cases the variation in temperature is less.

From the time that the mathematical relationships for the flow of fluids in pipes first began to be studied seriously until the present, there have always been students of hydraulics attempting to clarify and evaluate the friction factor f and the correlation of the constant C and its equivalent in the various flow formulas. Some of these believe that variable exponents for the diameter and velocity more nearly express the mathematically indeterminant friction factor for turbulent flow conditions; others still cling to the old Darcy formula because of the greater ease in computing. In view of the fact that most of the accepted formulas for fluid flow in pipes give comparable results which stem from the juggling of exponents and constants, it appears that the Darcy and Chezy equations are more readily adapted to the design of process and industrial piping systems because of their simplicity and the fact that the design data furnished the engineer are usually based upon estimated production conditions and are therefore too broad to warrant the greater degree of accuracy required in other types of work.

Table 2 shows the relationship of diameter and velocity to the loss of head due to friction. For each velocity and diameter of pipe the Reynolds number had been calculated and the friction factor f obtained from Fig. 7. Using this coefficient of roughness in the Darcy equation $h = f \frac{L}{D} \frac{V^2}{2g}$ and making L = 100 feet, the loss of head per 100 feet has been determined. However, the friction factor is for extremely smooth pipe and must be corrected to account for the variation in roughness which is not constant even in the same grade of pipe; the aging of the pipe caused by scale and impurities in the water; and also for the variations in temperature of the water which even though small do affect the character of flow. Table 2, therefore embodies a constant correction factor of 2 over the values determined from Equation 7 and Fig. 7, the result being that this table compares closely with other data on the loss of head due to friction in water pipes, but is slightly on the high side as the velocities are increased.

For design problems, where Q is in gallons per minute; V is in feet per second; and A is in square inches, the following relationships will prove helpful:

$$Q = 3.13\,AV$$

$$Q = 2.45\,D^2V$$

$$V = \frac{Q}{2.45\,D^2}$$

Next month, Mr. Unwin takes up the loss of head due to obstruction and shows how tables and formulas are applied to the solution of problems.

PUMPS FOR VISCOUS FLUIDS

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HEATING AND VENTILATING'S
Reference Section

Pumps for Viscous Fluids

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Included in the broad field of centrifugal pump application is the transfer or transportation of viscous liquids. Since the viscous properties of a liquid affect the amount of friction created by the liquid flowing in a pipe, logically enough, the properties of a viscous liquid influence the hydraulic performance of a centrifugal pump as compared with action of water.

IN order to outline the procedure of selecting centrifugal pumps handling viscous liquids, it is important that we understand viscosity as it applies to pumps and piping systems.

Viscosity, by definition, is that property which resists any force tending to produce flow. Viscosity is a property independent of specific gravity. There are several types of instruments or viscosimeters used to measure the degree of viscosity of liquids such as, to name a few, the Engler, Redwood, Saybolt, Scott, MacMichael, Ostwald and Magruder. The Saybolt Universal viscosimeter is the most common instrument employed in the United States, the Redwood instrument is widely used in England, and the Engler on the Continent. These three instruments are of the "efflux" type, that is, the degree of viscosity of a liquid is measured by the number of seconds of time required for a given amount of liquid to flow through a given size orifice at a constant temperature. For example, if 200 seconds are required for 60 cc of a liquid to pass through a Saybolt Universal viscosimeter at 100F, the viscosity of the liquid is said to be 200 Saybolt Seconds Universal (SSU) at 100F.

In conjunction with the Saybolt Second Universal viscosimeter, the Saybolt Furol viscosimeter is used widely in the United States for higher viscosity liquids. The term "furol" is a contraction of "fuel and road oils."

Fig. 1 shows the conversion of some of the popular viscosity measurement instrument values into the international metric measurement of kinematic poises. The absolute poise is equal to the force of one dyne per square centimeter per second. The kinematic poise K is the ratio of absolute poises u to specific gravity g of the liquid, or $K = u/g$. The poise is named for the French scientist, Poiseuille, and is the value or measurement of viscosity used in the calculation of pipe friction for viscous liquids. The centistoke or kinematic centipoise is equal to 1/100 of a kinematic poise.

The viscosity of a liquid varies indirectly with temperature. It is very important that the minimum pumping temperature of the liquid be known, for at its minimum pumping temperature the viscosity of the liquid is the highest. Viscosity values for any liquid may be plotted on semi-logarithmic paper against temperature with viscosity values on logarithmic increments. Knowing the viscosity at any two temperatures, but preferably any three, the viscosity for all temperatures can be obtained, since the viscosity-temperature curve is a straight line. As an example, the viscosity of common SAE motor oils at various temperatures is shown in Fig. 2. For comparison of fluidity or viscosity, water at 60F has a viscosity of 32 SSU.

Before we get into the calculations of pipe friction of viscous liquids, we should understand the effect viscosity has on the flow of a liquid in a pipe. There are two distinct types of flow within a pipe dependent upon velocity and viscosity of the liquid. The two types of flow are viscous or stream-line flow, and turbulent flow. Viscous or stream-line flow is the condition where the friction is cohesive in nature, or the friction is caused by one film of liquid sliding over an adjacent film since the velocity of the two films is not the same. In viscous flow the center of the stream has the highest velocity, and the velocity diminishes from the center to the wall of the pipe. Since friction is caused by the molecular cohesion of the films of liquid passing over one another, the smoothness or roughness of the walls of the pipe is not a factor and is not considered.

Turbulent flow is described as the condition of flow where the friction is both cohesive and adhesive in nature. In addition to the molecular cohesion of the film of liquid, there is also the condition, due to velocity, that causes eddies to form on the walls of the pipe, increasing the friction by adhesion of the molecules of liquid against the pipe walls. In turbulent flow, the velocity of the liquid is more nearly constant as compared with viscous flow, as illustrated in Fig. 3 and 4.

The method of calculating pipe friction caused by viscous liquids is shown in Fig. 5. Let us figure the friction loss for the following example: 200 gpm of oil having a viscosity 300 SSU and a specific gravity of 0.85, through 200 ft of new 3-in. cast iron pipe. From the viscosity conversion chart, Fig. 1, we find that 300 SSU is 0.66 poises kinematic. We next convert kinematic poises K into absolute poises u by the formula $u = K \times$ specific gravity. The absolute poises u equals 0.66×0.85 or 0.56 poises absolute. Our next

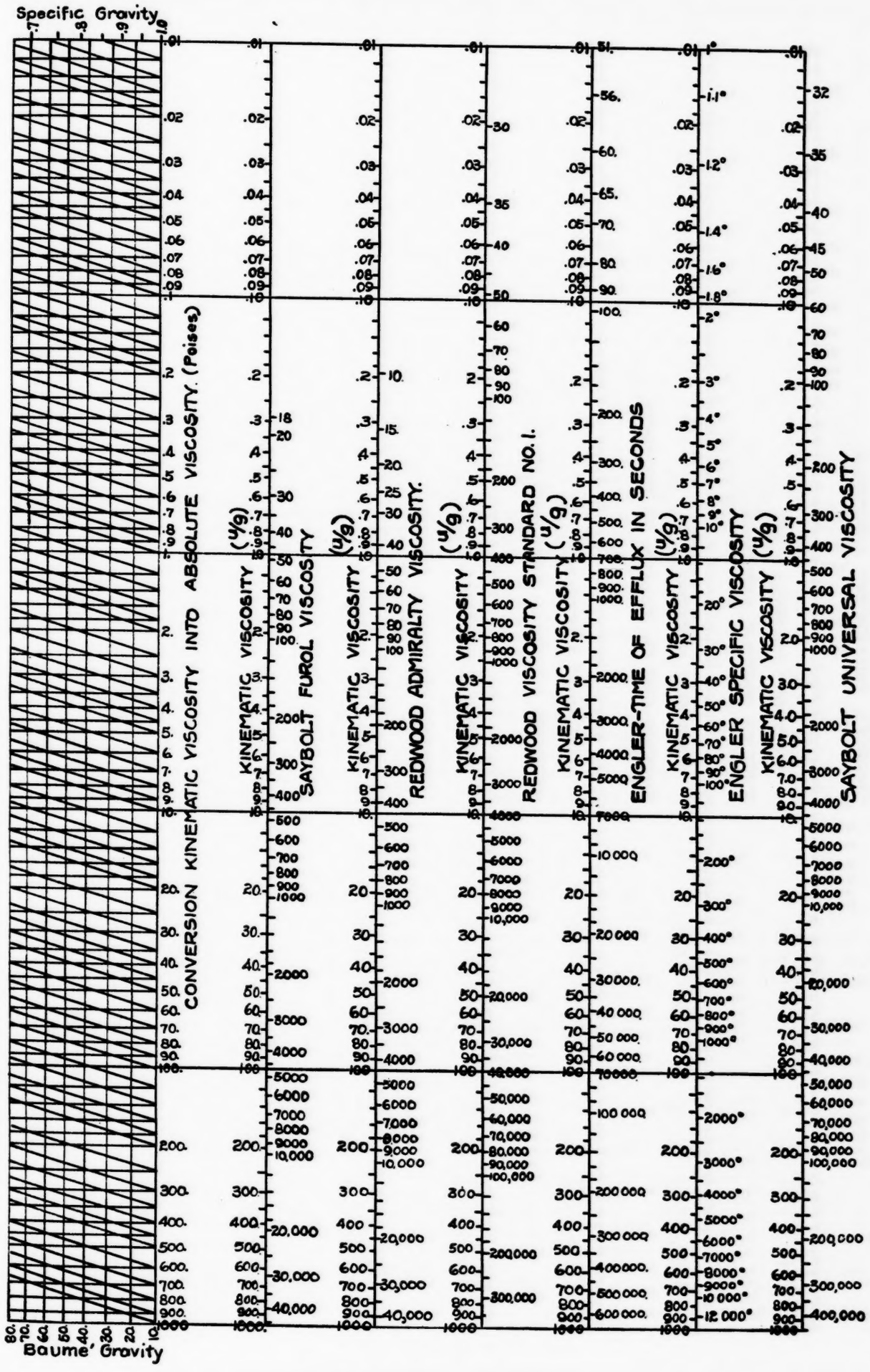


Fig. 1. Viscosity conversion chart.

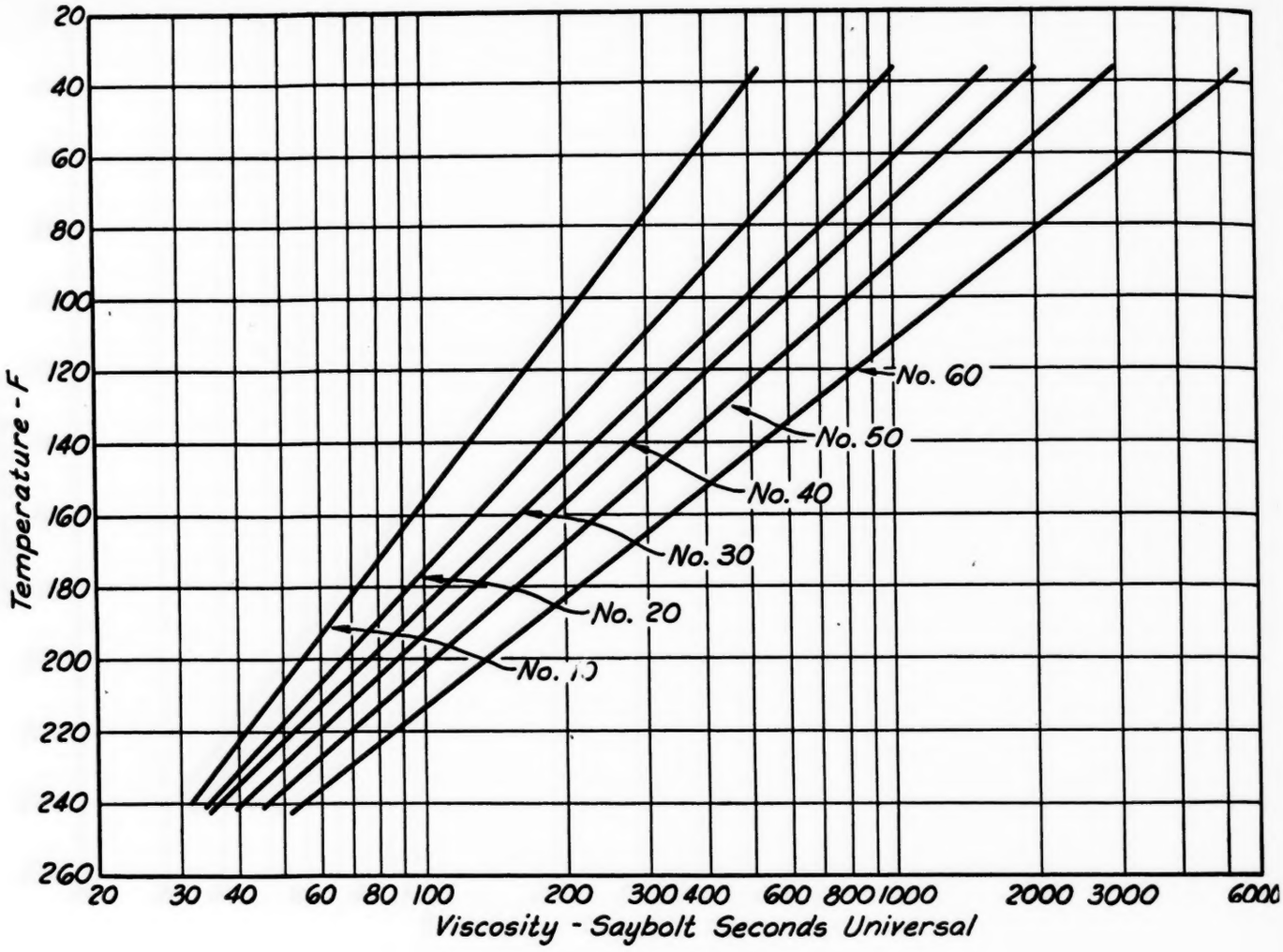


Fig. 2. Viscosity of typical SAE motor oils.

step is the determination of the type of flow. By formula 1, Fig. 5, we find:

$$T = \frac{0.85 \times 200}{3 \times 0.56} = 101.$$

Since T is more than 65, the flow is turbulent, and we therefore find the value of K^1 from the Curve EF (for new cast iron pipe). K^1 equals 0.685. Since the flow in the pipe is turbulent, we use formula 2 in determining the friction loss in feet per 100 ft of pipe

$$\text{or } H_f = \frac{.231 \times .685 \times (200)^2}{(3)^5} = 26 \text{ ft friction loss}$$

per 100 ft of pipe. For 200 ft of pipe our total friction loss would be 26.0 × 2 or 52 ft.

To further illustrate the friction loss chart, let us suppose that instead of 200 gpm our capacity is 120 gpm. We start by determining the type of flow

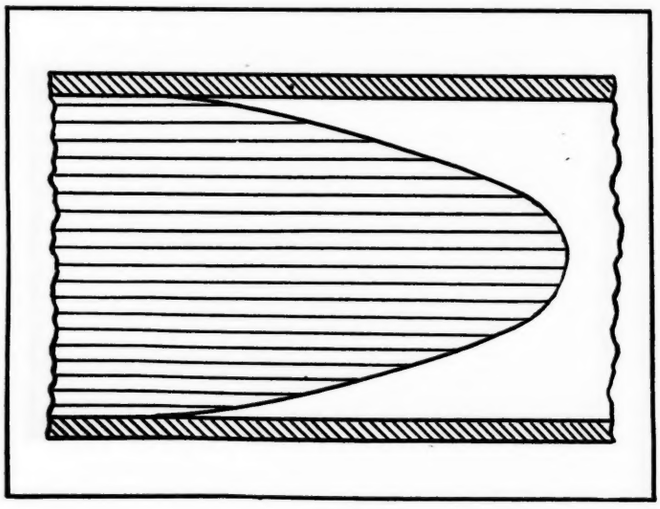


Fig. 3. Cross section parabola of viscous flow.

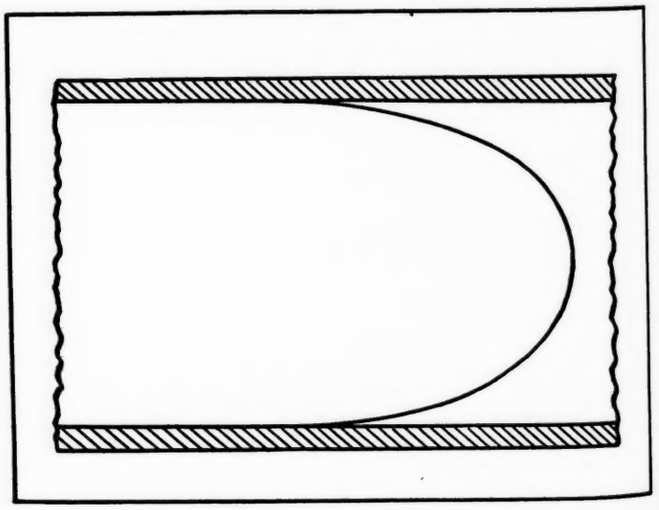


Fig. 4. Cross section of turbulent flow.

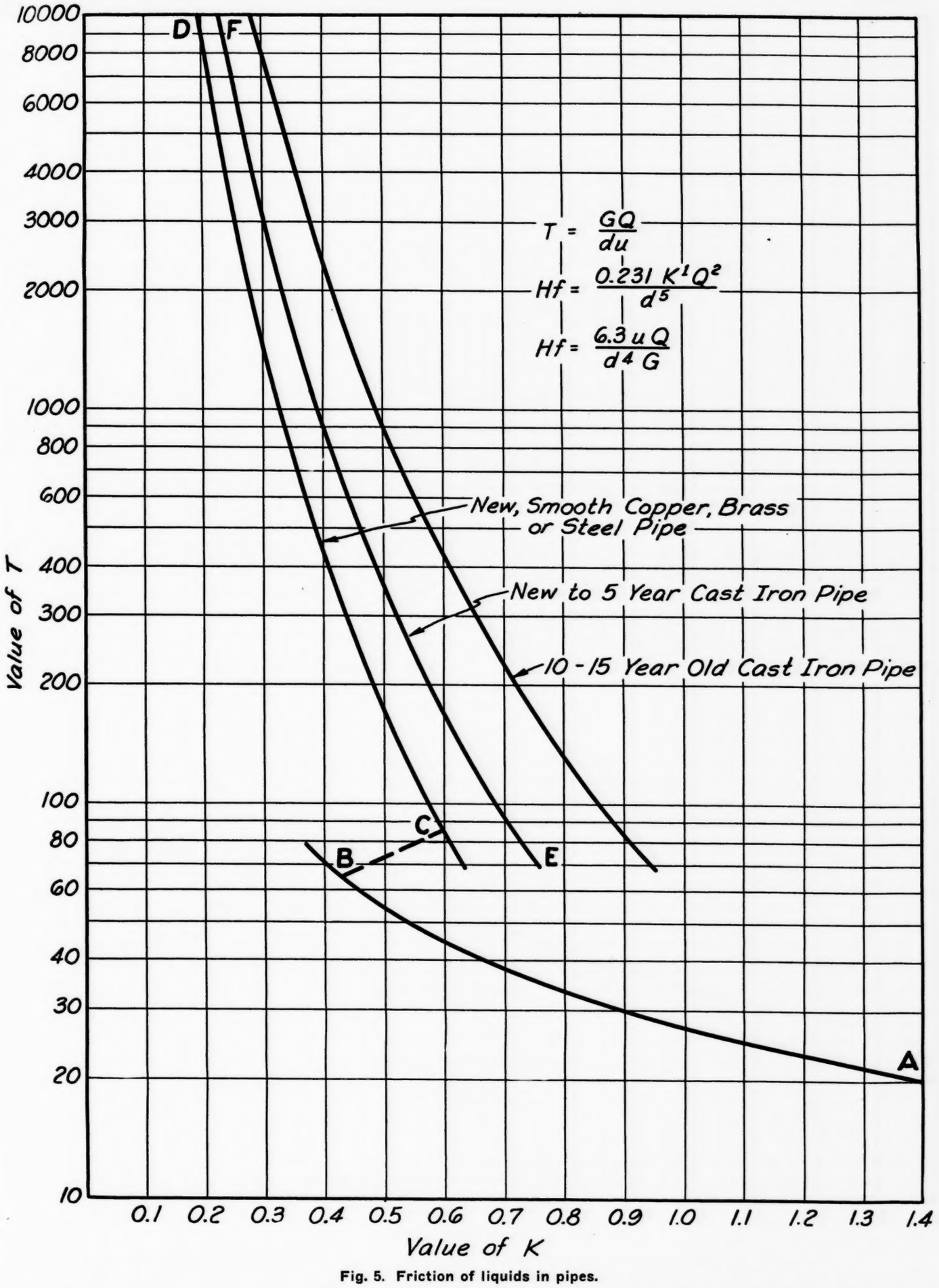


Fig. 5. Friction of liquids in pipes.

In formulas, G = specific gravity of liquid at flow temperatures; Q = flow capacity in gpm; d = inside diameter of pipe in inches; u = absolute viscosity of liquid in poises; H_f = head or friction loss in feet per 100 ft of pipe. When T is less than 65, use formula 3. T at 65 is the point of critical velocity. Line AB is streamline or viscous flow; BC, flow suddenly changes from streamline to turbulent flow; CD, turbulent flow.

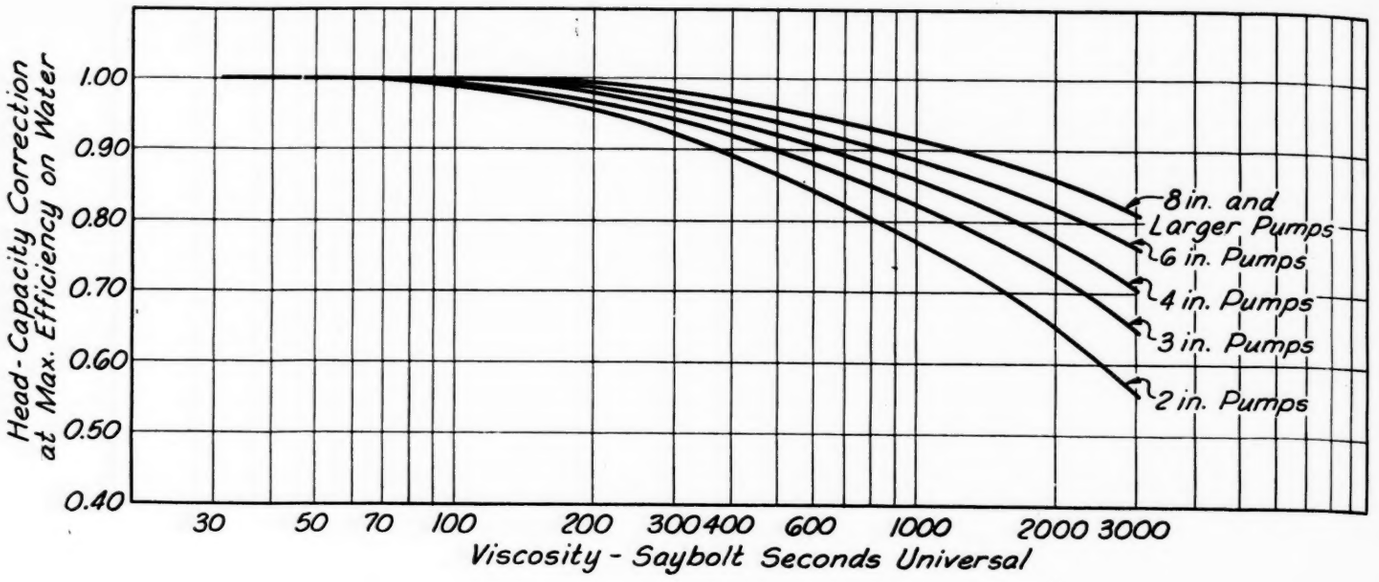


Fig. 6. Head-capacity factor.

$$T = \frac{0.85 \times 120}{3 \times 0.56} = 60.7.$$

Since T is less than 65, our type of flow is found to be viscous or streamline, and we use formula 3 of Fig. 5. Since the flow is viscous, no factor as to the smoothness of the pipe walls is involved. By formula 3, we find the friction loss

$$H_f = \frac{6.3 \times .56 \times 120}{81} = 5.23 \text{ ft per 100 ft.}$$

For 200 ft of pipe the total friction for 120 gpm is 5.23 $\times$ 2 or 10.46 ft. By comparison of the friction of 120 and 200 gpm of 300 SSU oil in 3-in. cast iron pipe with the friction of water at the same rate of flow in 3-in. cast iron pipe, we find from water friction tables at 200 gpm, a friction head of 18 ft per 100 ft of pipe as compared with a friction head of 26 ft per 100 ft of pipe of 300 SSU oil at 0.85 specific gravity. At 120 gpm of water, the friction is 6.98 ft per 100 ft; however, 120 gpm of 300 SSU oil of 0.85 specific gravity, being viscous or streamline flow, has in this case a lower friction head than water. In this case it is 5.23 ft per 100 ft of pipe. As to the friction loss in pipe fittings, it is general practice to use the values of "equivalent length of pipe", the same as used in calculating the friction of water in piping systems.

Up to this point, our discussion has not touched on how viscosity affects the performance of centrifugal pumps. The foregoing information on viscosity and pipe friction calculations for viscous liquids would, of course, apply in determining the total dynamic head of a piping system regardless of the type of pump to be used—rotary, plunger or centrifugal.

We have shown in pipes that the friction loss of viscous liquids in turbulent flow is higher than the friction loss for the same quantity of so-called non-viscous water. Therefore, it is logical that viscous liquids would create higher internal frictional losses in a centrifugal pump because the flow inside of the pump due to the high velocities is turbulent. The head and capacity of a centrifugal pump decreases as the viscosity increases. Power requirements of the pump increase with the viscosity due to lowered efficiency caused by increased disc friction of the impeller. The viscosity correction charts for head-capacity and efficiency, Fig. 6 and 7, are based on test data obtained for Goulds Pumps, Inc., by Robert L. Daugherty in cooperation with the Union Oil Company of California in 1924 and 1926. The data obtained by the Daugherty tests have been used extensively by the in-

Table 1—Values for Illustrative Example

Percent of 100% Capacity* (Q_p)	GPM (Water)	Head In Feet (Water)	Correction Factor Head & Capacity (C_v)†	GPM (Viscous)	Head In Feet (Viscous)
50	108	107	.9625	104	103
75	162	99	.9437	153	93.5
100	216	88.5	.9250 (C_m)	200	82
125	270	69	.9062	245	62.5
140	302	54	.8950	270	48.3

*100% capacity is capacity at maximum efficiency on water.

†$C_v = 1.00 - \left[\frac{(1.00 - C_m)\, Q_p}{100}\right]$

where C_m = head-capacity correction factor at maximum efficiency.

dustry for approximation of performance of centrifugals handling viscous liquids.

In order to familiarize ourselves with the correction charts, let us work an example: Capacity—200 gpm of oil having a maximum viscosity of 300 SSU at the minimum pumping temperature and a specific gravity of 0.85, zero or flooded suction, 176 ft of new 3-in. cast iron pipe and three 3-in. 90° standard elbows on the pump discharge and a static discharge head of 30 ft.

From standard tables of equivalent length of pipe, we find the 3-in. elbows are each equal to 8 ft of 3-in. pipe and therefore the total equivalent length of pipe is 176 plus 24 or 200 ft. Our previous example of pipe friction for this desired capacity, same viscosity and specific gravity, was calculated to be 26 ft per 100 ft or 52 ft friction total. To the friction loss of 52 ft we must add the static discharge head of 30 ft, making a total dynamic head of 82 ft.

We must therefore select a pump capable of delivering 200 gpm at 82 ft head of 300 SSU oil. From inspection of pump performance curves on water we find the rating of 200 gpm, 82 ft total dynamic head, falls in the range of a 2-in. pump. From the chart of correction factors for head-capacity, Fig. 6, we read up from 300 SSU and find the head-capacity correction factor for a 2-in. pump to be 0.925.

In order to assist in selecting the proper pump, we convert our oil rating of 200 gpm, 82 ft head into a so-called water rating by dividing each, the head and capacity, by 0.925. We then have a rating of 216 gpm, 88.5 ft. This water rating is the impeller design rating we would require in order to produce a capacity of 200 gpm of 300 SSU oil at 82 ft total dynamic head providing our water rating falls in the maximum efficiency field of the pump we select.

We find from pump performance curves on water that a 2-in. discharge pump at 3,500 rpm best meets this particular condition and has its maximum efficiency at this rating of 76%. We then plot the water performance of this pump for head, capacity, efficiency and brake horsepower based on water at 1.00 specific gravity as shown by solid line curves, Fig. 8. We now approximate the complete performance of this 2-in. pump based on 300 SSU oil at 0.85 specific gravity as shown by dash lines. The previously mentioned Daugherty tests showed that the head developed by a centrifugal pump at shut-off or against a closed discharge valve was essentially the same for liquids of various viscosities as for water. Therefore, we assume we have the same shut-off head for both the 300 SSU oil and water. Using 216 gpm, which is the capacity at maximum efficiency as 100 percent, we next calculate the approximate head-capacity values for the remainder of the head-capacity curve for 300 SSU oil. Since at shut-off the head-capacity factor is unity, we proportion the correction factor to capacity to complete the curve.

For example, at 50% of 216 gpm or 50% of capacity at maximum efficiency our head-capacity correction factor would be one-half the difference between unity and the head-capacity correction at maximum efficiency subtracted from unity or 0.9625. By multiplying 108 gpm by 0.9625, and by multiplying by 0.9625 the head developed on water at 108 gpm which the curve shows to be 107 ft, we have a head and capacity for 300 SSU oil of 103 ft at 104 gpm.

By the same procedure we calculate the performance

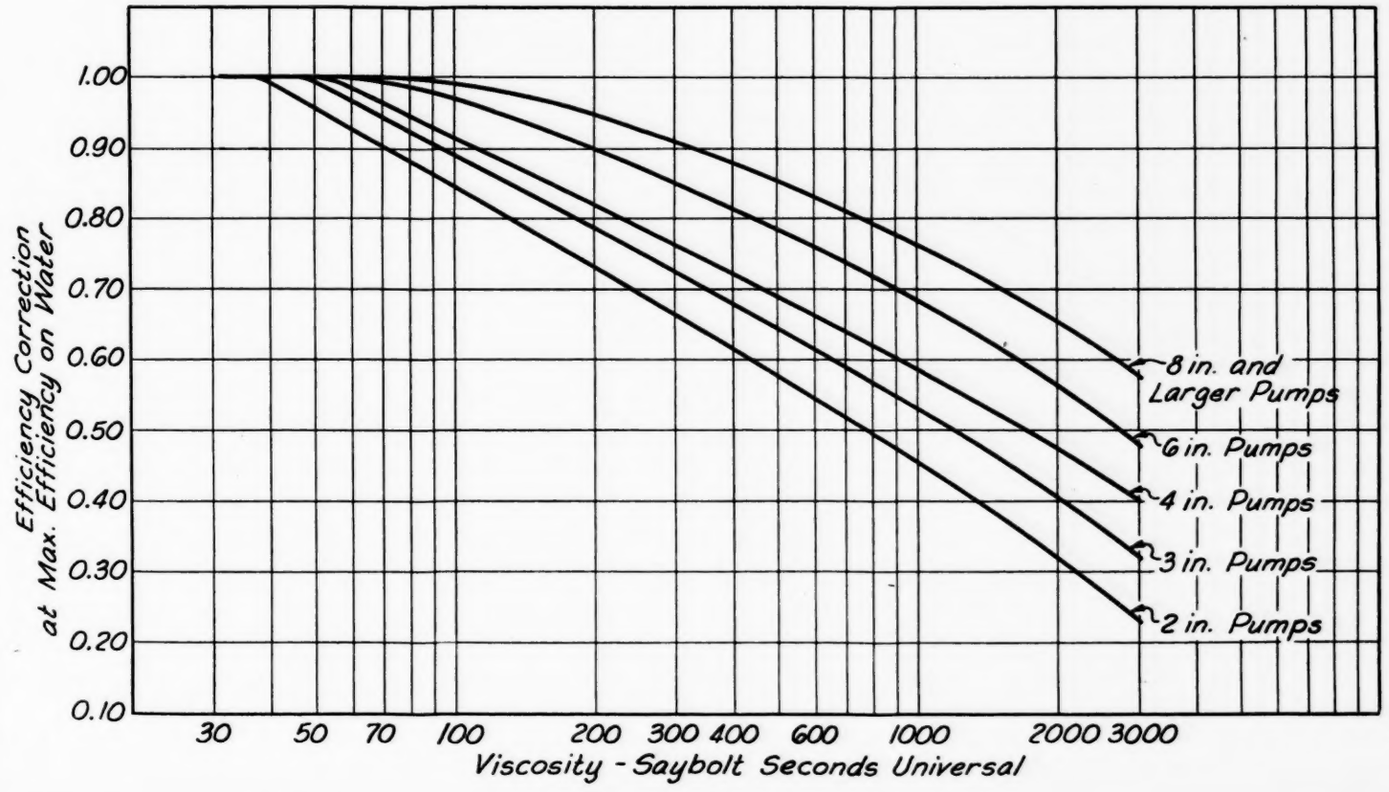


Fig. 7. Efficiency factor.

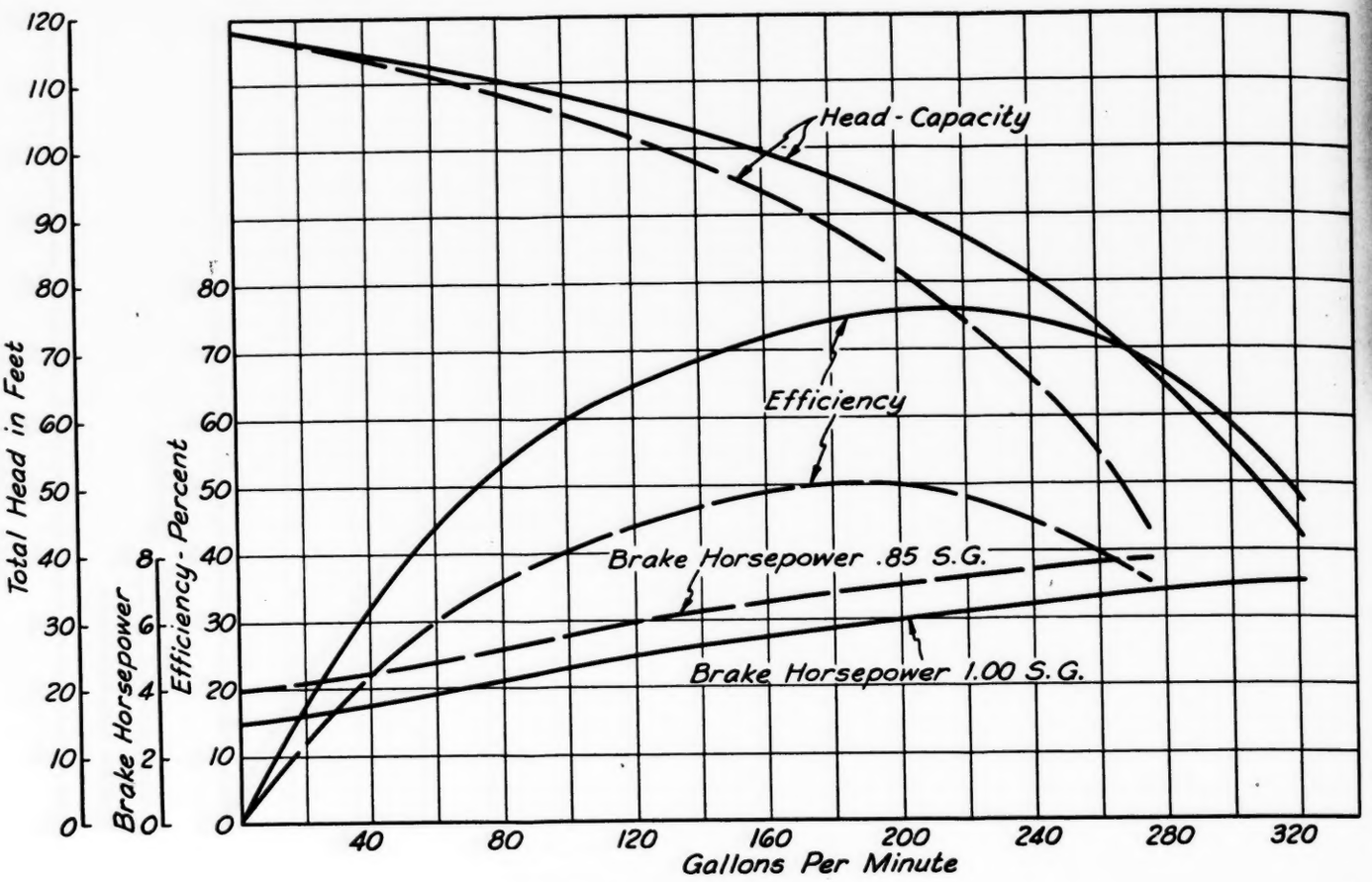


Fig. 8. Pump performance.

at 75, 125 and 140% of capacity at maximum efficiency on water. These values are worked out in Table 1 and are plotted as shown in Fig. 8.

Our next step is to calculate the approximate efficiency and brake-horsepower characteristics of the pump. From the efficiency correction chart, Fig. 7, we read up from 300 SSU to the 2-in. pump curve and find our correction factor to be 0.66. This factor is the percentage of maximum efficiency on water. Our maximum efficiency on water being 76%, we multiply 76 by 0.66 and find the efficiency at 200 gpm to be 50%. We now determine the horsepower requirements for this rating of maximum efficiency which in this particular case is also our rating point. The horsepower required for 200 gpm, 82 ft head at 50% efficiency and 0.85 specific gravity is 7. This horsepower point is plotted on our curve.

From the Daugherty tests, it was found that the horsepower curves for pumps handling viscous liquids paralleled the horsepower curve of the same pump handling water, the horsepower difference being very nearly the same throughout the capacity range of the pump. We therefore complete the horsepower curve for the pump handling 300 SSU oil by drawing it parallel to the solid line horsepower curve on water, passing the curve through the previously calculated 7 brake horsepower point at 200 gpm.

The complete efficiency curve is now drawn by calculating points at various capacities knowing the horsepower and head developed at the various capacities. The specific gravity of the liquid must not be forgotten in the efficiency curve calculations. The approximate performance of this pump handling 300 SSU oil at 0.85 specific gravity is now complete.

Although the calculations outlined may at first seem complicated, it is necessary that we go about selecting the pump for a viscous liquid application in the manner outlined in order to be assured of satisfactory pump performance on the job.

In general, pumps for liquids 70 SSU and below require no correction factor for head-capacity, but correction factors for efficiency should be considered to insure sufficient horsepower for the unit. Pumps for viscous liquids should be selected with the water rating as near as possible to the maximum water efficiency in order to insure as high efficiency as possible at the viscous liquid rating. Nearly all applications involving viscous liquids are installed with a flooded suction or the liquid flows to the pump. Installations involving suction lifts should be submitted to the pump manufacturer with full details including the vapor pressure of the liquid at the maximum and minimum pumping temperatures. The data contained concern only true liquids having no particles in suspension.

Applications involving viscosity values in excess of 1200 SSU should be checked by the pump manufacturer to make sure the horsepower requirements do not exceed the mechanical limitation of the pump.

It should be remembered that the correction factors in Fig. 6 and 7, while secured from test data, are not necessarily exact for all pumps. We have, however, the belief, based on experience and use of these data over a period of years, that satisfactory results from their use will be obtained.

Outdoor living room with the cable placed in the ceiling which is 18 ft at the ridge.

After the heating cable is fastened, plaster is applied parallel to the direction of the element runs.

Radiant heating through the use of electric heating cable has been proven economical in areas enjoying a low power rate. In the accompanying article this system is described and power consumption data tabulated for a representative group of houses in an area with a design temperature of 10F.

Radiant Heating by Electricity

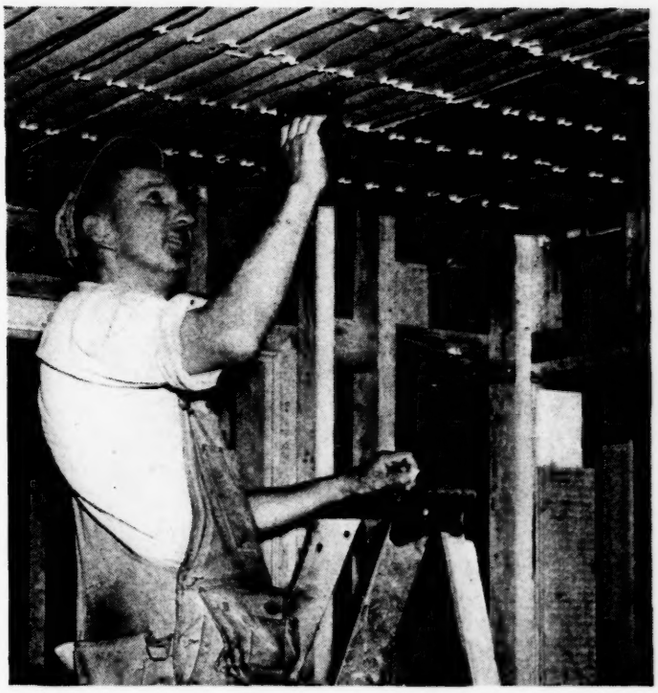
L. N. ROBERSON
L. N. Roberson Co., Seattle, Wash.

RADIANT heating, based on the practice of embedding special electrical heating cable in the walls, ceiling or floors or in combination of these three surfaces, has been used successfully for the past six years in the Pacific Northwest. With this system, the yearly power consumption for the average house is 1.27 kw per cu ft.

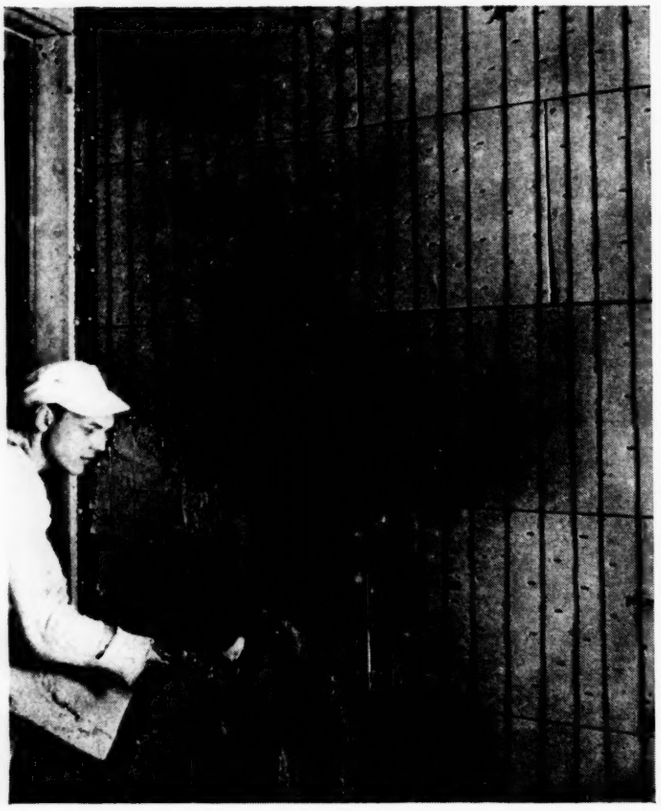
The special heating cable used as a radiant heating source was developed by the L. N. Roberson Co., Seattle, Wash. It is insulated with a plastic that has high resistance to water, acid and alkali. It is approximately ⅛ in. in diameter, has a high electrical strength, and the ability to withstand continuous temperatures of 167F.

This heating element as the basis for a radiant heating system was first installed mostly in the homes of men in the electrical or engineering profession. However, there are now over 300 installations in the Pacific Northwest. Backed by the experience of heating these homes, it is now possible to present full details regarding this new system of heating.

An interesting thing about this system of heating is that each room is considered as a separate heating unit with its own thermostat control. This permits compensation for solar heat gain which changes from room to room, and for the heat gain due to lighting fixtures and electrical appliances.



Using a stapling machine to attach the asbestos loops to the ceiling. Cable loops are kept several inches from the walls to permit metal reinforcement at the corners without the chance of the metal touching the cables. This gap prevents a humming in the reinforcement.



Heating elements on a wall. Note that the elements are run vertically to facilitate the application of plaster.

Let us now consider design calculations. Design procedure followed by the author is to have a room air temperature of 68-72F.

Design Calculations

In a general way, the heating load required for the average house may be determined by allowing 1.5 watts per cu ft for rooms 2,000 cu ft and over, and 2 watts for rooms of smaller size. As the Heatsum heating cable is available in 200, 250, 400, 500, 1,500 and 3,000 watt sizes, the designer uses the size element larger than the total wattage required for the room. Where more than one element is required, then two or more elements of the same size should be used to simplify control.

The author tries to obtain for the insulated ceiling a *U* factor of between 0.005 and 0.007. This is usually achieved with 3.5 or 4 in. of non-combustible fill over the ceiling. For an exposed wall and floor 0.25 is used, and for concrete floor slabs on the ground where some form of insulation such as a highway expansion strip is used to separate the slab from the footings and exposed walls, 0.19. Where such provision is not followed, 0.30 is used. A soil temperature of 50F is assumed. Sandy soil in this area acts as an insulation in conjunction with the floor, as well as a heat storage. The *U* values given have been demonstrated adequate through the many installations in service.

Since cold shadows are left under tables and desks when the angle from the extreme source of ceiling heat is less than 45° vertical, part of the heat source for such cases should be from a wall or floor. As an example, a 5 x 7 ft bathroom with an 8 ft ceiling would have an angle of less than 45° to the extreme sources of heat when a person stands in the center of the room. Therefore a good design for this room would be to apply heat in the wall back of the tub or in the grout for the tile floor. If the wall is an exposed one, it should be filled with pour type, non-combustible insulation or equivalent heat insulation.

Typical design calculations for a ceiling panel heated room are given in Table 1. In this case, after arriving at the maximum design demand by the conventional design method, a check was made to see how the results compared with the rule of thumb just mentioned.

Application of Cable

Once the design calculations have been made and the proper heating elements and runs selected, the cable is not difficult to apply. Where attics are accessible, it may be attached to the top of the plaster lath or plaster board from the attic side by means of insulated staples, or by loops of asbestos cord placed around the cable and fastened to the lath or board by a stapling machine. It may also be held in place by patching plaster. From three to four inches of non-combustible insulation is placed above the cable to direct the heat downward.

Because the cable acts as a reinforcement over joints in plaster board, no metallic reinforcing is required, particularly at any point where it will have to be crossed by the heating cable. Disregard of this fact

Table 1 — Typical Design Calculation for a Ceiling Panel Heated Room

1. (Ceiling area in sq ft) × (*U* factor for plaster board and plaster plus 3⅝ in. vermiculite insulation) or 256 × .07 = ...	18
2. (Floor area in sq ft) × (*U* factor for hardwood floor over fir sub-floor) or 256 × .34 =	87
3. (Window area in sq ft) (*U* factor for glass) or 37 × 1.13 = ...	42
4. (Net exposed wall area in sq ft) × (*U* factor for brick veneer, 1 in. wood sheathing, ½ in. rigid insulation, ½ in plaster) or 169 × .20 = ...	47
5. (Cubic contents) × (Hourly air changes by infiltration, 1 wall exposed) × (Btu per F per cu ft of air) or 2048 × 1 × .018 = ...	37
6. Exposed door area	0
Total Btu per F per hour — No. 2 to 6...	213
A. (Item No. 1) × (Max. ceiling temp. minus min. outside design temp.) or 18 × (84 — 10) = ...	1,332 Btu
B. (Sum of 2 to 6 incl.) × (Surface temp. of room side of exposed surfaces minus outside design temp.) or 213 × 50 = ...	10,650 Btu
Total....	11,982 Btu
C. (Correction factor for heat gain from lights, space occupied by furniture, etc.) × (Total Btu divided by Btu per kw hr) or $.8 \times \frac{11{,}982}{3{,}413}$ = 2.8 kw, maximum design demand.	
CHECK: (As room has over 2,000 cu ft of contents, 1.5 watts per cu ft is used.) $\frac{(1.5)\ (2048)}{1000}$ = 3.07 kw. Use 3 kw element.	

Table 2 — Cost and Consumption Data on Electrical House Heating Equipment

House	No. Rooms	Cu ft Air Space	Connected Heating Load KW	KW Consump. 1945	Total Annual Bill 1945, $	Annual KW per Cu Ft	Annual Cost per Cu Ft, $	Construction
1.	6	16,750	12.0	30,510	253.49	1.82	.015	Brick veneer
2.	5	6,400	10.5	26,460	245.78	4.07	.038	Frame
3.	6	7,750	9.2	12,740	144.20	1.65	.019	Frame
4.	5	6,000	9.0	16,500	157.19	2.75	.026	Frame
5.	5	6,800	7.5	20,080	170.04	2.95	.025	Frame
6.	5	6,450	9.0	16,000	160.65	2.48	.025	Brick veneer on tile
7.	5	7,800	7.5	15,258	121.44	1.95	.016	Frame
8.	8	22,800	15.5	24,168	226.46	1.06	.01	Brick veneer
9.	5	6,150	13.5	19,062	191.35	3.10	.031	Frame (also 2 hp pump)
10.	6	9,280	10.5	29,768	246.49	3.21	.027	Frame
11.	5	8,000	9.5	14,318	144.55	1.79	.018	Frame
12.	4	9,950	18.3	22,180	228.54	2.24	.024	Frame
13.	7	19,500	19.5	30,557	249.41	1.65	.013	8 in. brick furred and plastered
Average						2.36	.022	

REMARKS: All houses have ceilings insulated with 3 to 3½ inches of non-combustible fill type insulation. Houses 7 and 12 also have walls insulated. House 8 has three baths. House 12 has two baths. House 2 has 32% glass walls. House 9 consumption and cost figures include a 2 hp pump.

Cost and consumption figures include electricity consumed for *all* purposes, including lighting, cooking, water heating, etc. All of the houses were heated by radiant heat from cables installed in the ceiling or floor.

will cause a hum in the metal reinforcing when current is flowing through the heating element.

The use of the stapling machine for attaching the cable to the ceiling is shown in Fig. 3. After the cable is secured, a brown coat is applied parallel to the heating elements. This coat should be allowed to dry for at least three days before heat is applied through the embedded cables to finish the drying. The brown coat must be thoroughly dry before applying the finish coats. A sand finish may have the heat turned on in three or four days or as soon as the wet appearance of the plaster disappears. If the heat is turned on sooner, a water mark may develop to show the location of the heating element runs, and this discoloration will even show up through calsomine. When a putty coat is used, 7 or 8 days should be allowed for drying to avoid checking.

Magnesite flooring may be poured over the cable in a manner similar to plaster. However, the scratch coat with considerable sawdust added is applied first, the element stapled to the scratch coat, and then the finish coat applied over the heating element.

For concrete floors, the element is placed on the first three inches of concrete, with an additional inch of cement poured over the cable.

Cable leads from the concrete may be brought to a terminal box by a conduit, providing the leads are separated in the conduit by loom, glass or asbestos sleeving. Not more than two leads of one circuit should be placed on one conduit.

Where practical, the thermostat for each room is located on an inside wall about five feet above the floor, and above the switch that controls the circuit. It should be located in a wall that does not contain the heating element. A heating element in the wall adjacent to the thermostat causes very erratic temperature control.

The author has found that a concrete floor will sweat around the edges of rugs and carpets and also on the bare concrete when the system is designed to employ only the ceiling and/or walls as the heat source. However, such a condition may be corrected by placing a heating element in the floor where a concrete floor is used.

A concrete floor, it was found, requires about four hours to come up to temperature. When the current is turned off during the evening hours, the tempera-

Portable decorative screen containing sufficient electric radiant heat for a small bedroom or bathroom. These thermostatically controlled units are also available with three and four panels.

Table 3 — One Year's Monthly Bills for House No. 12

Month	Non-Heating		Heating	
	KWH	Cost, $	KWH	Cost, $
January	414	6.43	2196	19.84
February	962	10.28	1928	18.79
March	888	9.75	1542	14.72
April	632	8.00	988	8.37
May	682	8.30	538	4.07
June	558	7.45	242	1.70
July	588	7.65	32	.24
August	580	7.60	80	.57
September	636	8.00	224	1.57
October	798	9.15	562	4.62
November	818	9.25	2162	20.72
December	914	9.95	3216	31.52
Totals	8470	101.81	13.710	126.73

ture will drop 10F overnight. However, one week is required to drop back to the normal temperature of the soil below the concrete floor.

Plaster ceiling and walls reach a comfortable temperature from a cold start in about 30 minutes. Several hours may be required before the heat shuts off after it is turned on for the first time. After plaster has had a sufficient heat charge, the element is rarely on more than one-third of the time. Due to the diversification between rooms, the highest demand by a demand meter over a six-year period was 34% of the connected load.

The temperature differential between floor and ceiling is less than 3F even though a room has a 20-22 ft ceiling.

Brick veneer houses using this heating system show a better over-all heat economy than frame houses, although a calculation of comparative wall heat losses would indicate the reverse to be true.

Cost of Operation

From an engineer's point of view, the important thing about any system is its economics—what does it cost to operate?

Cost and power consumption data for a group of 13 houses are given in Table 2. The figures include the cost of lighting, cooking and water heating as well as space heating. Since the houses listed are on rate schedules which vary from 0.7 to 1 cent per kilowatt hour on the final rate step, the kilowatt hour consumption is a better index of heating performance. In most of the homes listed in the table, the final rate step is obtained after using $5 worth of electricity.

In Table 3 is presented a monthly analysis of the heating cost of house No. 12 of Table 2. In this case it was possible to separate heating cost from the non-heating bill.

Tests conducted in the winter of 1945 on the author's residence (House No. 13) by Washington State College in conjunction with the Puget Sound Light and Power Co. showed that the power consumed per room when the heat was turned off upon retiring and then turned on again in the morning, was the same as when the heat was left on continuously.

Electric radiant heat has proven economical when the power rate is one cent or less per kilowatt hour. With higher rates, the engineer must decide whether the convenience and other features of this form of heating warrant the additional operating cost.

Results of Studies of Air Conditioned Trolley

Studies of data obtained during the actual operation of the Carrier air conditioned trolley coach in service in Atlanta, Ga., indicate that the usually accepted figure of 400 Btu per hour given off by the average seated passenger is not applicable because a large portion of the passengers were standing and most of the passengers entered the coach following a period of activity which greatly increased the rate above the 400. It was found that, under these conditions, the average passenger gives off 600 Btu per hour.

While the trolley coach is designed to seat 44 passengers, it has carried loads up to 110 passengers. Most of this passenger heat load is latent heat of moisture evaporated from the body and this makes moisture removal and humidity control a most serious problem.

Vehicle doors were kept open for about 20% of the time the coach was in service. To reduce the large onrush of warm outside air when the doors open, air pressure slightly above normal is maintained inside the coach. This also helps to reduce the entrance of fumes and dust by infiltration during operation.

Even under extreme conditions, air conditions inside the coach can be maintained between 72 and 78F, and the humidity between 50 and 65%. Outside temperatures above 90F were encountered and outside humidity approached 100%.

The first air conditioned trolley coach in Atlanta was so successful that the Georgia Power Co. ordered 100 additional air conditioned coaches. Based on the studies made in Atlanta, the new designs were predicated on lighter peak passenger loading. It was believed that although there might be times when the coach would be overloaded, it would not occur as frequently as during the war years.

The new design calls for about one-half the weight of the experimental equipment. Air conditioning equipment has to be self-contained so that extensive installation work would not be required.

These facts were brought out by Gerard Keane of the Carrier Corp., before a section meeting of the ASRE held in Utica, N. Y.

Using a Low Pressure Steam Trap as a Flash Tank

T. W. REYNOLDS

Discussion of the problem of venting re-evaporated high pressure steam to a low pressure steam main.

A READER proposes to discharge high pressure condensate, as collected at a rise in a 6 in. steam main at 100 lb pressure and of apparently 100 ft run, into a 3 in. low pressure heating main which varies in degree of vacuum up to around 20 in. Since the flash tank is too distant, he wants to know how workable his scheme is (shown in dotted lines in Fig. 1), also how long a run of high pressure steam main can be drained in this manner. Note that the sketch, as amended, calls for certain pipes to be increased in size at the low pressure trap to accommodate the volume of steam flashed.

The proposed scheme is not new; neither is it commonly done. In general, its success depends only upon a reasonable amount of condensate as discharged into a heating main having a demand for steam equal to that as received from the high pressure steam main. Unlike most heating systems, the vacuum in the problem presented extends back into the steam main, so the case is a bit more complicated. This is due to the greater amount of flash or re-evaporated steam when entering a main into which there is as much as 20 in. vacuum. Drainage is another factor. Is the drainage normal, or does it also include the first rush of condensate when occasionally heating the high pressure main up from cold?

Since the heating main is a steam and not a return main, it should receive only the flash steam, not the condensate. The water itself should go to the vacuum return main. Due to the large size of the high pressure steam main, it must be located in an industrial plant and utilized year around. What then becomes of the benefits of the flash steam in the summer months when the heating main has no use for the steam and would in any event only return the condensate cold to the vacuum pump by the time it reached that piece of equipment?

As a summer operation, both condensate and flash could be by-passed directly to the return with the pump operated on float switch. However, pump operation would be so infrequent that heat in the condensate would be lost en route. Obviously, during the heating season the trap could not be allowed to discharge into the return as the return main might have insufficient condensing surface to dissipate the flash steam. Furthermore, any raising of the pressure in the return would make its pressure higher than in the steam main and of course the various heating system traps would not discharge against a higher pressure.

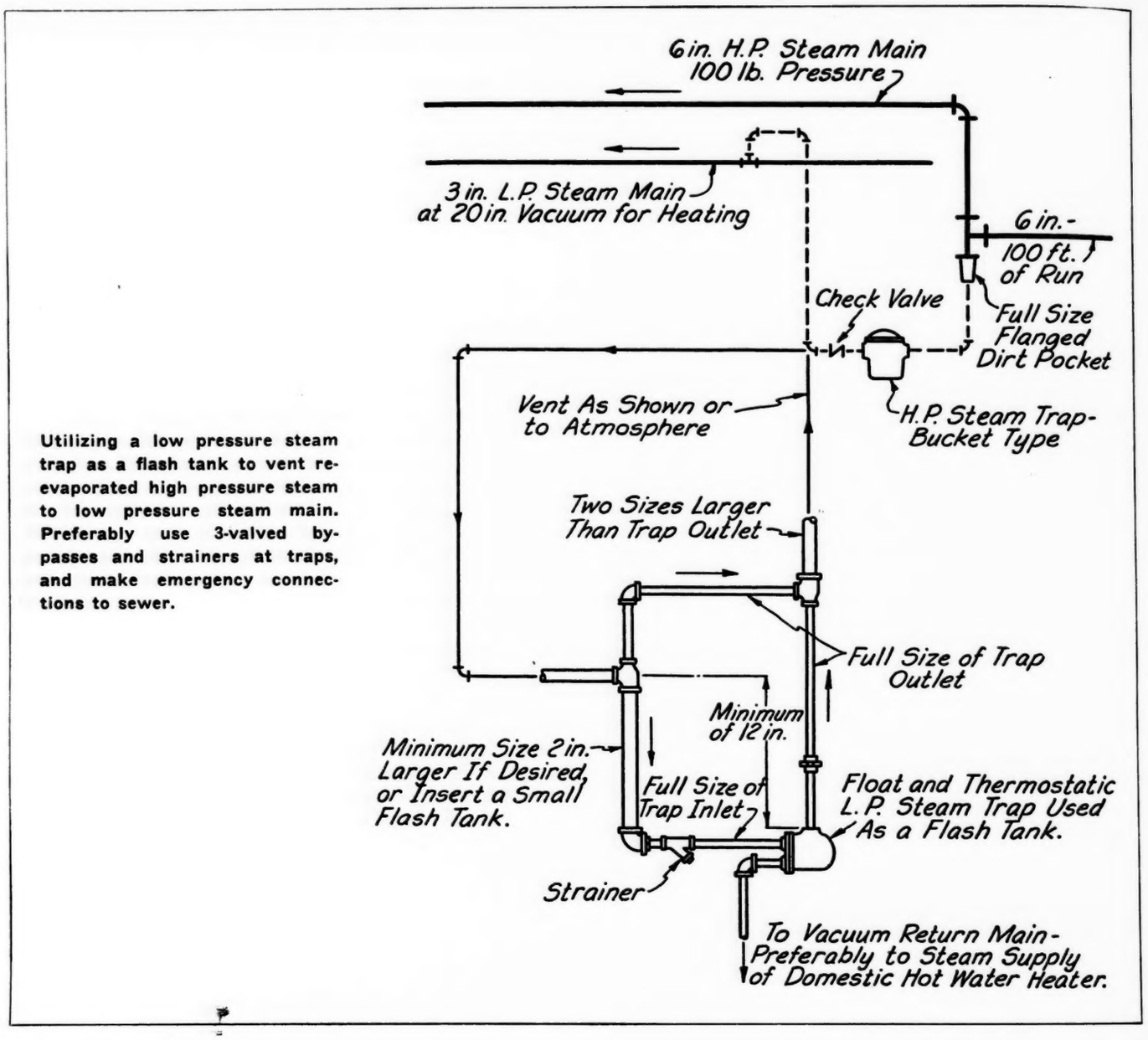
All of the conditions are not known. Suppose, for example, that there is a domestic hot water heater not far away. This is equipment utilized the year around so that the solution becomes simple. Just discharge the condensate to a connection at the hot water heater, somewhere between the heater control valve and the heater inlet. The condensate can flash therein without disturbing anything and will be immediately utilized, both flash and the remaining heat in the condensate. While the control valve is open there would be less flash because the heater will be operated at higher pressure than would be the case in the vacuum heating main.

Assume now that there is no nearby hot water heater and that the reader desires to utilize the flash for all it is worth during the heating season. In such a case, the answer to how much damage the flash steam will do in breaking the vacuum in the heating main can be determined as follows:

Assume 100 ft of high pressure main; if more, increase the amount of condensate proportionately. Such a main weighs 1877 lb and contains 173 sq ft of exterior heat losing surface. Specific heat of its metal or heat units required to raise the metal one degree is about 0.12. The room can be assumed at 70F with 80F at ceiling, steam temperatures above 32F are 309F and 130F for the two mains. At the lower steam pressure the latent heat is 1000 Btu; 879 Btu at the higher pressure.

The amount of flash steam, or the amount of steam that will re-evaporate as the high temperature condensate enters the low pressure main, is the difference in the heat of condensate (above 32F) at the two pressures, divided by the latent heat at the lower pressure. The excess of sensible heat at the higher pressure above that of the sensible heat at the lower pressure will furnish the latent heat necessary for re-evaporation.

A bare steam main at 2 lb pressure will lose 300 Btu per sq ft of surface per hour (steam 215F, room 70F). For 100 lb steam (temperature 341F and considering 2% increase in heat coefficient per each ten degree variation from this), the heat loss will be increased from 300 to 338 Btu. Therefore, (173 sq ft of surface $\times$ 338 Btu) $\div$ 879 Btu latent heat $=$ 67 lb condensate in the high pressure main if left uncovered. Assume pipe insulation 70% efficient, then 30% $\times$ 67 lb $=$ 20 lb of condensate to be discharged into the



Utilizing a low pressure steam trap as a flash tank to vent re-evaporated high pressure steam to low pressure steam main. Preferably use 3-valved by-passes and strainers at traps, and make emergency connections to sewer.

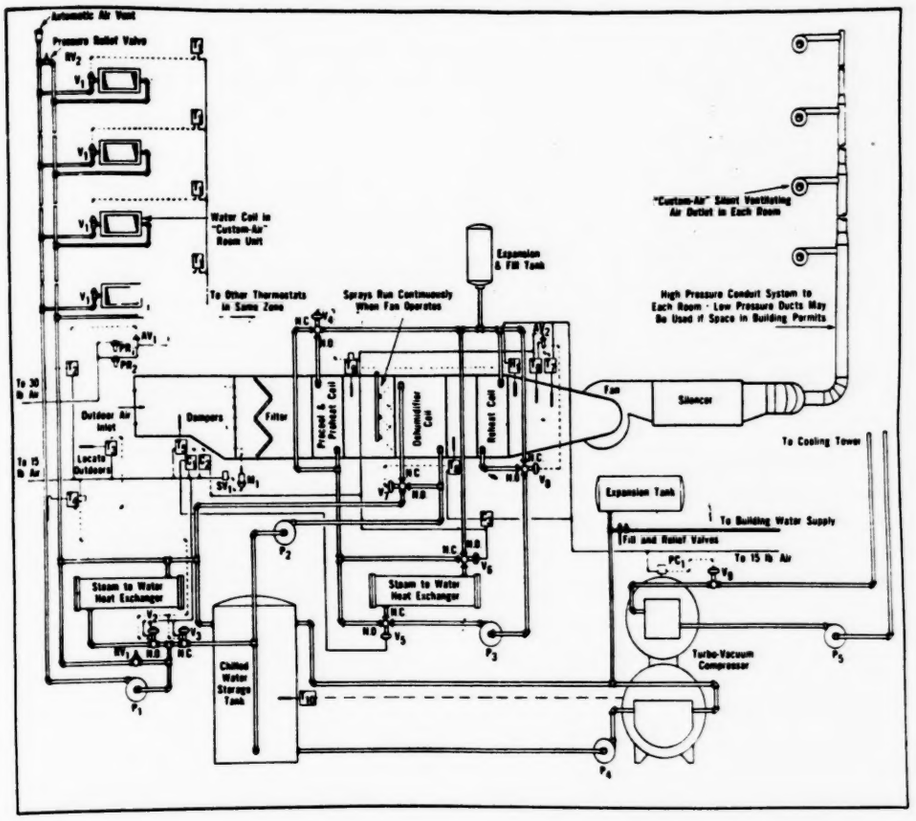
heating main. The main is 3 in. and probably is sized to supply no more than 2000 sq ft of radiation at 2 lb pressure. Therefore (2,000 sq ft × 240 Btu) ÷ 966 Btu latent heat at 2 lb = 497 lb of steam supplied by the heating main.

The amount of flash will be (309F — 130F) ÷ 1,000 Btu latent heat = 0.18 lb × 20 lb of condensate = 3.6 lb. This is less than 1% of the 497 lb of steam supplied by the heating main and should therefore give no trouble, though it may raise the pressure in that main slightly. As the volume of steam per pound at 20 in. of vacuum is 74 cu ft the flash will occupy the space within 14 lineal ft of the 3 in. main.

If the main is started up from cold, the condensate will greatly increase. Thus, 1,877 lb × 0.12 specific heat × (341F — 60F) = 63,400 Btu. This divided by 879 Btu latent heat = 72 lb of condensate per hour, or if the heating up period takes place in 5 minutes, the condensate will be at the rate of (60 ÷ 5) × 72 = 864 lb per hour. As the flash is 0.18 lb or 18% of the condensate, the total steam flashed will be 18% × 864 lb = 155 lb. This is about one-third of 497 lb, the amount of steam supplied by the heating main and is certainly a lot of flash steam to discharge into the heating main, as is also the 864 lb of condensate itself. The only hope, in such an event, is that the heating main is also being started up from cold at the same time and that all the traps on both mains, including these as shown, are of sufficient capacity to pass the flood.

The reader knows best the local conditions and can use his judgment in connection with the basic figures herein supplied. In the final analysis, considering the 220 days in a heating season and the hours of operation at say 10 hours, the condensate could be wasted to the sewer with a loss of only a little over two tons of coal per heating season, an amount relatively small in an industrial plant. It is partially offset by the saving in first cost of piping changes otherwise made. However, as a year around proposition with a hot water heater available nearby, but not used for the purpose in mind and the discharge going instead to the sewer, there would be a waste of seven tons of coal annually.

NEWS OF EQUIPMENT AND MATERIALS


Automatic Air Vent
Pressure Relief Valve
Water Coil in "Custom-Air" Room Unit
To Other Thermostats in Same Zone
Sprays Run Continuously When Fan Operates
Expansion & Fill Tank
"Custom-Air" Silent Ventilating Air Outlet in Each Room
High Pressure Conduit System to Each Room - Low Pressure Ducts May Be Used if Space in Building Permits
To 30 lb Air
To 15 lb Air
Outdoor Air Inlet
Locate Outdoors
Dampers
Filter
Preheat & Precool Coil
Dehumidifier Coil
Reheat Coil
Fan
Silencer
To Cooling Tower
Expansion Tank
To Building Water Supply
Fill and Relief Valves
Steam to Water Heat Exchanger
Steam to Water Heat Exchanger
Chilled Water Storage Tank
Turbo-Vacuum Compressor

Multi-Room Air Conditioning

NAME—Trane Custom-Air system of air conditioning.

PURPOSE — Air conditioning the multi-room, multi-story building.

FEATURES—System consists of an individual unit in each room space and a separate central system. Room units recirculate and filter air to offset heat losses or gains in the space in which they are located. Outside air, properly humidified or dehumidified, is supplied through the central system through a high or low pressure system of duct work. Central system is independent of room units. Where high pressure duct work is used, a fitting has been developed which reduces high pressure air to low pressure and diffuses it to the room without noise. It is possible to heat in one room and cool in another in the same zone because the air temperature from the central system is kept below room temperature. The amount of heat provided by the room units can be cut down or increased as desired. Even though the central system is out of operation, the room units circulate air and provide heating and cooling. This system provides for heating or cooling in a few offices without operating the entire system. The whole system need not be turned on to provide comfort for a few after-hours workers. Air from the central system and units is separate. Some of the abbreviations used in the drawing are: NO, normally open; NC, normally closed; P, pump; T, thermostat.

MADE BY—*The Trane Co., La Crosse, Wis.* **132**

Ammeters and Voltmeters

NAME—USG ammeter and voltmeter.

PURPOSE—Electric power measurement.

FEATURES—Dials have a scale length of 80 degrees of arc on the center zero type scale and 60 degrees of arc on the zero off-counter scale. Pointer oscillation is said to be reduced to a minimum by a special movement. Dials come either with black numbers on white background or the reverse.

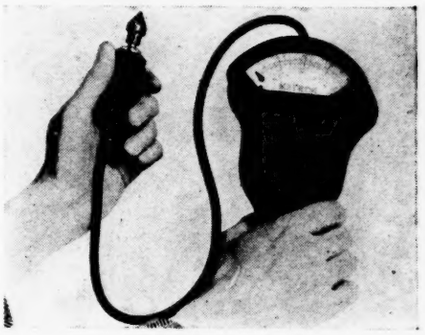
MADE BY—*United States Gauge Division, American Machine & Metals, Inc., Sellersville, Pa.*.... **133**

Tachometer

NAME—Metron low speed tachometer.

PURPOSE—For measuring speeds of rotation from 10 to 1,000 rpm.

FEATURES—Instrument consists of two units, a head which is placed against the rotating shaft to be measured, and an indicating unit.



Instrument has speed range of 10 to 200, 20 to 400, and 50 to 1,000 rpm. By finger tip control, speed range can be changed while making a measurement, without any danger of damaging the instrument. The head contains only one rotating part mounted in permanently located bearings.

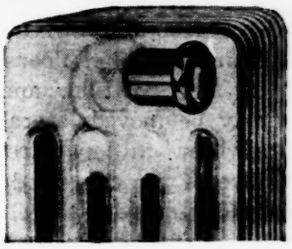
MADE BY—*Metron Instrument Co., 432 Lincoln Street, Denver 9, Colo.* **134**

Radiator Air Valve

NAME—No. 27 Auto-Vent.

PURPOSE—For use with hot water radiators and convectors for removing entrapped air from system.

FEATURES—Valve is 2½ x 2 in. diameter, and is made of brass with nickel plated finish. Monel metal is used for the bearings, levers and spring, and neoprene for the valve seat. As air accumulates in the radiator or pipe line, it is automatically released.



MADE BY—*Maid-O'-Mist, Inc., 3217 N. Pulaski Rd., Chicago 41, Ill.*.. **135**

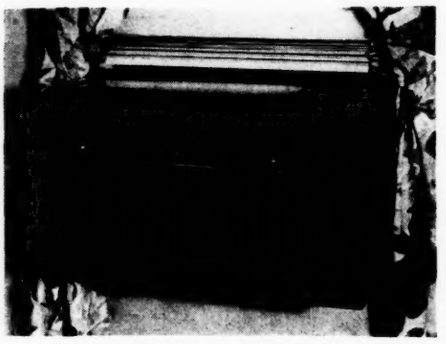
Unit Heater

NAME—Modine unit heater.
PURPOSE—Space heating and heating for processing work.
FEATURES—As part of a new line of three models, a "power-throw" has been added to provide heated air discharge over a long range. Heaters have integral, all-brazed units. Copper fins are mechanically and metallically bonded to tubes. Cas-

ings are acoustically insulated for quiet operation and are bonderized for rust protection before being painted. In addition to standard outlets, the vertical units may be equipped with Truncone deflectors, anemostats and louvers.
MADE BY—*Modine Manufacturing Company, Racine, Wis.* **136**

Room Conditioners

NAME—Yorkaire room conditioners.
PURPOSE—Units for individual room cooling and ventilating.
FEATURES—Units are designed for year round operation—cooling in summer and straight fan operation when cooling is not required. A sliding curtain may be adjusted to admit any degree of ventilation desired. Four air outlet doors may be set at any position, and the louvers may be moved laterally to control air flow in any direction. Controls are of the concealed type.
SIZES AND CAPACITIES—Model 1, for rooms 15 x 19 ft, has a ½ hp motor and can remove 5,250 Btu per hour when the outside temperature is



90F dry bulb and 75F wet bulb. Model 2 for rooms 20 x 20 ft has a ¾ hp motor and under the same conditions can remove 7,500 Btu hourly. Model 3, console type, has a ¾ hp motor, can remove 9,000 Btu hourly and is designed for rooms up to 20 x 25 ft.
MADE BY—*York Corporation, York, Pa.* **137**

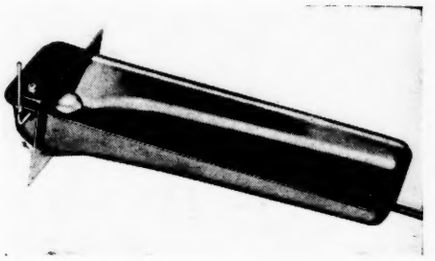
Pump

NAME — VW-1 positive pressure vane-type pump.
PURPOSE — Designed for pumping

non-lubricating liquids such as water.
FEATURES—Pump has two composition bearings which require no lubrication beyond that furnished by the liquid being pumped. Vanes are held intact with the pump chamber. Unit is designed for use in systems having a relief valve and therefore it has no bypass valve built into the unit itself. Pump has a mechanical rotary seal. Unit is powered by a 1/15 hp Universal motor which can operate either on a-c or d-c. Delivery is about ½ gpm.
SIZES AND CAPACITIES—For operating pressure to 30 lb per sq in.
MADE BY—*Eastern Engineering Co., New Haven, Conn.* **138**

Humidifier Pan

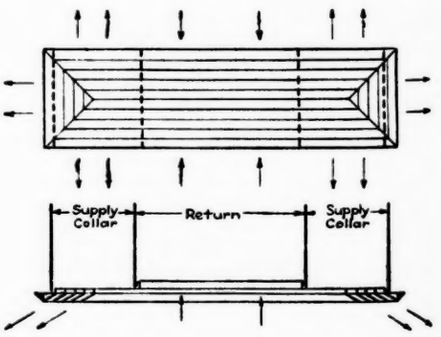
NAME—Olsen No. 10 humidifying pan.
PURPOSE—Humidifying pan for warm air furnaces.
FEATURES—Pan has a capacity of 1.5 gallons and can be installed in either a round or square casing furnace. Pan has a large evaporating surface. Unit illustrated is provided with a No. 46 automatic float control. However, pan, which has a heavy coating of vitreous



enamel, can be supplied without the float valve.
MADE BY—*The C. A. Olsen Mfg. Co., Elyria, Ohio.* **139**

Air Diffuser

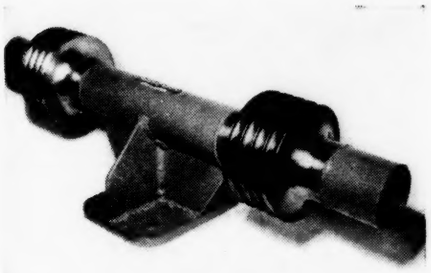
NAME—Agitair air diffuser—RS42.
PURPOSE—For applications where a combination supply and return air ventilating unit is desired.
FEATURES—Unit is square or rectangular in shape and requires little ceiling head room. Diffuser permits both ducts to run in same plane with separate connections for supply and return air. Makers



claim it eliminates special cutting and sealing to prevent supply air leakage.
MADE BY—*Air Devices, Inc., 17 E. 42nd St., New York 17, N. Y.* **140**

Anchor Joint

NAME—MagniLastic anchor joint.
PURPOSE—An anchor for pipe that allows for thermal expansion and contraction.
FEATURES—Joints are of stainless steel, Monel, Inconel and copper to meet the common corrosive condi-



tions. Temperatures handled are from —300 to 1,600F. A variety of standard fittings such as elbows and tees can be incorporated to make a single compact unit. Welding ends are regularly supplied, with pipe flanges and inner linings optional. Compensation for thermal expansion and contraction is achieved by varying the number of bellows on either side of the anchor base to meet conditions.
SIZES AND CAPACITIES—Made for standard pipe sizes from ½ to 24 in. Several models of expansion flanges are available to handle pressures up to 1000 lb.
LITERATURE AVAILABLE—241M.
MADE BY—*MagniLastic Division, Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.* **141**

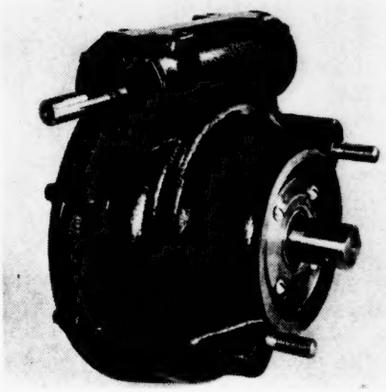
Small Motor

NAME—Eemco motor.
PURPOSE—For continuous service where a light 2 hp explosion proof motor is required as in fan, blower and pump drives.

FEATURES—Normal armature speed is 9,000 rpm but where lower speeds are required, an integrally built gear reducer is supplied which adds two pounds to the basic weight of 15 lb. Ball bearing motor has glass insulation and it can be operated for continuous duty with a temperature rise of 75C over an ambient temperature of 25C. It can be supplied for operation on 28, 32, or 110 volts d-c.
MADE BY—*Electrical Engineering & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles, Calif.* **142**

Stoker Drive

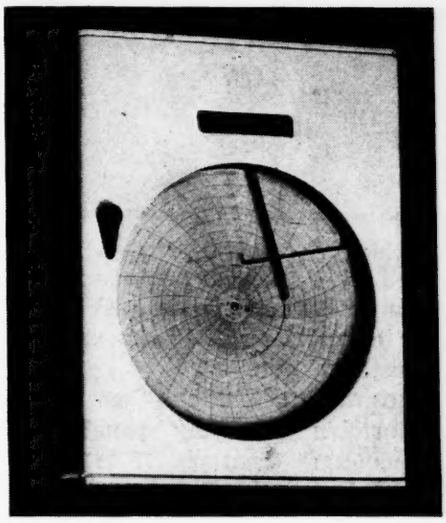
NAME—Universal stoker drive.
PURPOSE — Operating drive for screw feed coal stokers for both home and industrial use.
FEATURES — A single cone-drive gear and pinion developed by the Cone-Drive Division of the Mich-



igan Tool Co. is used to replace the customary worm gear set. This drive arrangement keeps 14 teeth in continuous contact so that each tooth carries about 7% of the load. Cone-drive gear set has a ratio of 400 to 1. Since tooth pressures are low for the smaller size stoker drives, cast iron is used instead of bronze for the gear running against a steel pinion.
SIZES AND CAPACITIES — Drives available for the 11 basic screw feed stoker sizes. No. 1 is for stokers from 15 to 50 lb per hour. The largest size is for units handling from 250-1,200 lb coal per hour.
MADE BY—*Stoker Drive Co., Frederick, Md.* **143**

Recording Thermometer

NAME—Minneapolis-Honeywell refrigerated locker plant thermometer.
PURPOSE—To record the refrigerated temperatures in a locker plant.
FEATURES — Instrument covers a 100F temperature range from



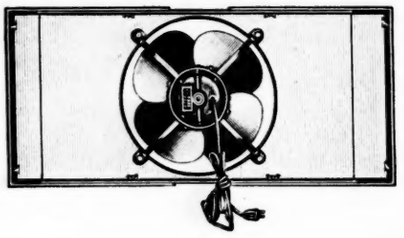
—30F to 70F and is provided with a 7-day chart. Using a mercury filled thermal system, the thermometer permits evenly spaced chart graduations over its entire range. An optional arrangement is a reverse chart which has temperature recordings nearer to the chart perimeter for easier reading. To comply with state laws, the chart may be operated by an electrical or hand wound clock mechanism. A smooth white enamel case makes the instrument easier to clean.
MADE BY—*Minneapolis-Honeywell Regulator Co., 2753 4th Ave. S., Minneapolis 8, Minn.* **144**

Lagging Adhesive

NAME—Arabol lagging adhesive.
PURPOSE—For use in securing lagging material to pipes and ducts.
FEATURES—Adhesive dries in four to six hours and leaves a finish which requires only one coat of paint. It can be applied to fiberglas, canvas, asbestos, or similar material.
MADE BY—*The Arabol Mfg. Co., 110 E. 42nd St., New York 17, N. Y.* **145**

Kitchen Fan

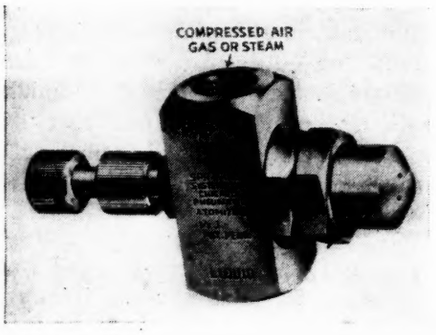
NAME—Emerson 12-in. kitchen ventilating fan.
PURPOSE—For kitchen ventilation.
FEATURES—Unit has large overlapping blades for exhausting a large volume of air. It is equipped with a fully enclosed, dust-proof motor designed for long periods of opera-



tion without overheating. Ventilator operates on 53 watts and exhausts 900 cfm.
SIZES AND CAPACITIES—Comes with adjustable mounting panels for windows or transoms 27 to 48 in.
MADE BY — *The Emerson Electric Manufacturing Company, St. Louis, Mo.* **146**

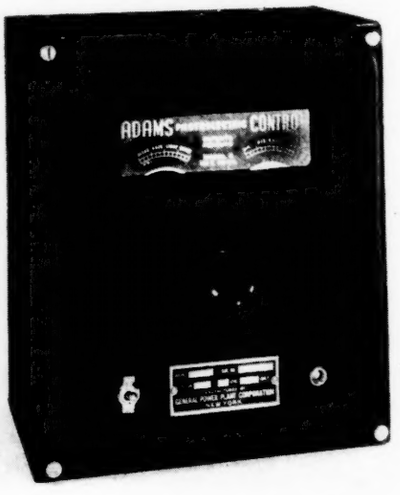
Atomizing Nozzle

NAME—Pneumatic atomizing nozzle for ½ in. pipe connection.
PURPOSE—Large capacity spraying system nozzle.
FEATURES—While this unit is built to operate with compressed air, other gases or steam can be used. Nozzle is of the internal mixing type, and although unit illustrated has a shut-off needle, it can be supplied without this feature. Nozzles are made of brass or stainless steel.
SIZES AND CAPACITIES—Sizes to handle 20, 40, or 60 gph.
MADE BY—*Spraying Systems Co., 4031 W. Lake St., Chicago, Ill.*..**147**



Combustion Control

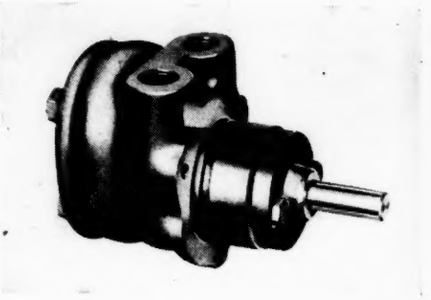
NAME—Adams photoelectric control.
PURPOSE—Air control for proper combustion of fuel oil.
FEATURES—With this photoelectric control, makers claim that just enough air is admitted to properly burn the fuel oil. The CO_2 content of the gas, it is said, can be held to within ½ of 1%.
OPERATION—A photoelectric cell determines the amount of haze present in the flue gas. Every 8 seconds, a synchronous motor operates a device which tests the haze value. If the test shows a variance from the desired value, a reversible motor activates an operation which energizes the damper motor to cor-



rect the air flow and thus reestablish the desired haze value.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY—*General Power Plant Corp., 381 4th Ave., New York 16, N. Y.* **148**

Rotary Pump

NAME—Roper Series K rotary pump.
PURPOSE—Small pump for pressures up to 150 lb. For use as a fuel supply pump for industrial and large domestic oil burners and for diesel fuel oil transfer work.
FEATURES—Pump is designed for handling clear liquids and for suction lifts up to 25 ft. Semi-steel packing gland has bronze bearing. The grooved hub section of back plate is designed for hub mounting and interchangeable mounting brackets. Pump has a built in relief valve and a special mechanical seal for operating at temperatures as high as 250F. This seal is self-aligning and self-adjusting to seal



tighter with an increase in pressure.
SIZES AND CAPACITIES—¾, 1½ and 3 gpm.
LITERATURE AVAILABLE—Bulletin 10.
MADE BY—*George D. Roper Corp., Rockford, Ill.* **149**

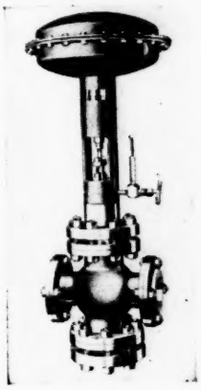
Check Valve

NAME—Greer check valve.
PURPOSE—A poppet type check valve for high and low pressure systems.
FEATURES—Valve consists of one piece aluminum alloy or steel housing provided with two hexagonal sections to facilitate installation; a hollow aluminum alloy poppet; a compression spring and a retaining

ring. The poppet is said to permit smooth flow without retarding the quick closing action of the valve if the direction of flow should suddenly reverse. Arrows are stamped on the valve housing to indicate direction of flow.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY—*Greer Hydraulics, Inc., 454 18th Street, Brooklyn 15, N. Y.* **150**

Diaphragm Control Valves

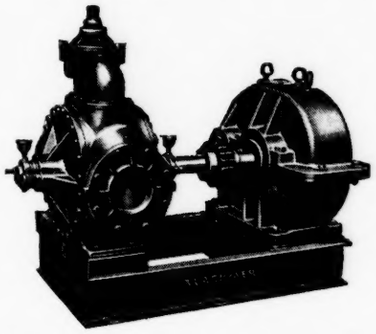
NAME — Hammel-Dahl diaphragm control valves.
PURPOSE—Flow control.
FEATURES—Body construction is rated at 600 lb maximum working pressure at 750F. Face-to-face dimensions are in accord with ASA standards. Split flange construction enables valve to be changed from point to point at different pressure ratings by replacing the removable flanges. Valve has a steel diaphragm superstructure with two-ply Neoprene diaphragm. Standard air pressure range is from 2 to 15 lb per sq in. Airfin bonnets are available for high temperature service.



SIZES AND CAPACITIES—Valves come in sizes from ½ to 1 in. in alloy construction, either in 304 or 316 stainless steel, or can be obtained in other corrosion resistant alloys.
MADE BY — *Hammel-Dahl Co., 243 Richmond St., Providence 3, Rhode Island.* **151**

Pump

NAME—Blackmer heavy duty pump.
PURPOSE—For pumping fuel oil and heavy fluids.
FEATURES—Internal construction is bronze fitted. Units are fitted with either anti-friction or sleeve bearings. The prime mover, either engine or electric motor, is mounted separately.



SIZES AND CAPACITIES—750 gpm at 150 lb per sq in. operating at 225 rpm. Will also be made with speed variations from 150 to 400 rpm and capacities of 200, 300 and 400 gpm, with pressures from 50 to 150 lb per sq in.
MADE BY—*Blackmer Pump Co., Grand Rapids, Mich.* **152**

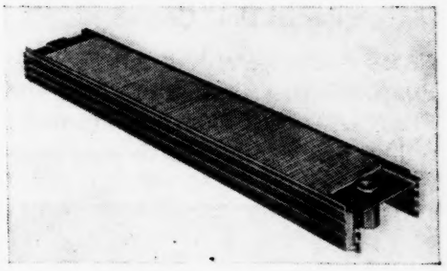
Percentage Timer

NAME—Cramer type PE percentage timer.
PURPOSE — For automatically controlling percentage of time at which an electrical circuit can be closed or opened out of a definite length of time.
FEATURES—Timer is easy to read and graduations may be in percentage of time or directly translated to feet per minute, gallons per hour, or degrees of temperature. Timers will repeat within 0.25% of any given setting and are completely enclosed in dust-proof bakelite housings.

LITERATURE AVAILABLE — Bulletin 2500-B.
MADE BY—*The R. W. Cramer Co., Centerbrook, Conn.* **153**

Convector

NAME—Modine convector.
PURPOSE—General space heating.
FEATURES—A new non-ferrous heating unit has been designed for the Modine line of convector heaters, and additional enclosure types and sizes have been incorporated in the line. Heating unit is non-ferrous throughout with headers, tubes and fines of copper or copper alloy. Design permits the use of one style heating unit on practically any two-pipe steam or hot water piping system. There are adjustable brackets for obtaining correct pitch and elevation of the unit. A choice of two types of air chambers is possible for use on hot water systems.



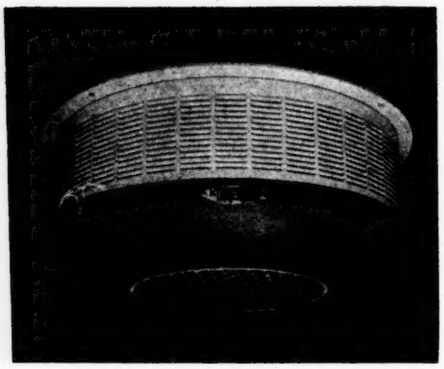
LITERATURE AVAILABLE — Bulletin 246 which illustrates the line of convectors and gives detailed dimensions.
MADE BY—*Modine Mfg. Company, Racine, Wis.* **154**

Low Temperature Cabinet

NAME—Bowser-Kold-Hold.
PURPOSE—Cold storage.
FEATURES—Temperatures as low as —150F can be obtained. Working compartment is 14 in. deep and 25 in. wide with the length different for the two models. Unit is insulated with Santocel. Cabinet comes on 4 in. casters.
SIZES AND CAPACITIES — Type T5-150 of 5 cu ft and type T11-150 of 11 cu ft capacities, both operated by a 60-cycle 3-phase repulsion type induction motor.
MADE BY—*Bowser, Inc., Refrigeration Div., Terryville, Conn.* **155**

Radial Unit Coolers

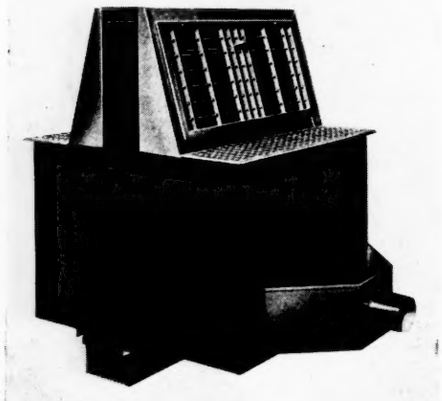
NAME—Kramer radial unit coolers.
PURPOSE—Distribution of air.
FEATURES—Unit is installed in mid-ceiling and occupies little overhead



space. It has an all copper coil; a totally enclosed, ball-bearing motor; a built-in heat exchanger and a bottom pan that is easily removable for access to all the interior parts. Discharge grille has been designed to break up the air into many small air streams and to discharge the air flow along the ceiling. The discharge velocity causes a large amount of eddy currents that produce a thorough mixing of the cold air that leaves the unit and the warm air in the box before it drops to the storage level.
LITERATURE AVAILABLE—Bulletin.
MADE BY — *Kramer Trenton Co., Trenton 5, N. J.* 156

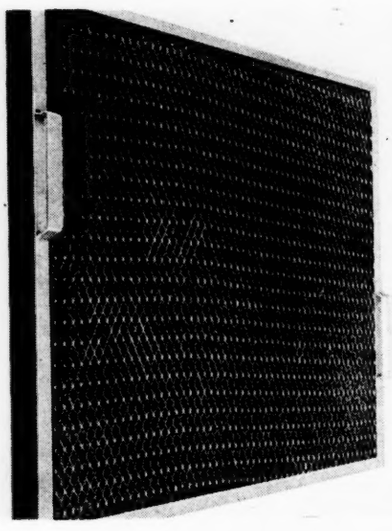
Floor Furnace

NAME—Royal model D-45,000 floor furnace.
PURPOSE—Space heating.
FEATURES—Dual floor furnace is hidden below the floor level and is of shallow flat bed construction. The fire box is 18 in. deep. Both pilot and burner valves are equipped with safety locks so that gas fumes do not leak into the space being heated. By cutting specified size holes in the floor and wall, the furnace can be set into place from above the floor.
SIZES AND CAPACITIES—Model D-45,000 for 45,000 Btu and Model D-55,000 has a capacity of 55,000 Btu input.
MADE BY—*Royal Heaters, Inc., 1024 Westminster Ave., Alhambra, Calif.* 157



Air Filter

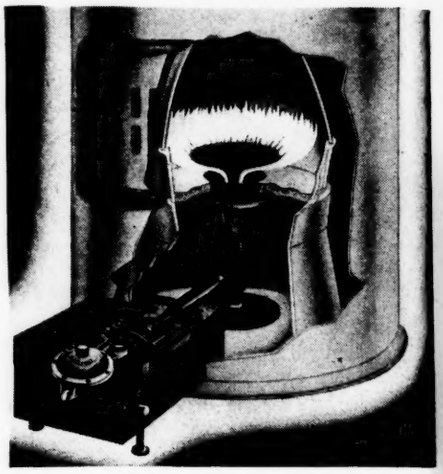
NAME—Agitair FM air filter.
PURPOSE—For filtering air traveling at high velocity.



FEATURES—Filter medium consists of expanded metal to induce turbulent cyclonic air action within the filter, thereby creating a centrifugal wiping action against the viscous surfaces of the filter medium. Unit is designed to handle 1,200 cfm through a 20 x 20 in. filter with an approach velocity of 432 fpm. Filter frame is constructed of cold rolled steel and the parts are arc welded.
LITERATURE AVAILABLE — Bulletin FM101.
MADE BY—*Air Devices, Inc., 17 E. 42nd Street, New York 17, N. Y.* 158

Conversion Gas Burner

NAME—Barton conversion burner.
PURPOSE—For converting round or rectangular warm air, hot water or



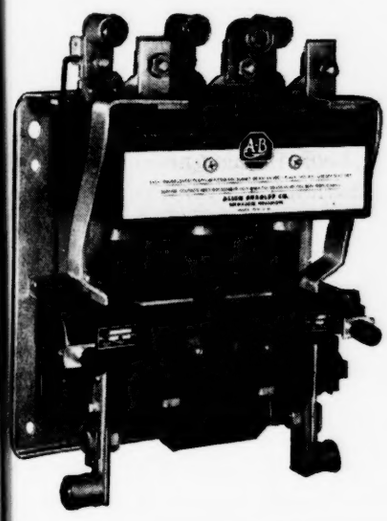
steam furnaces to the use of gas as a fuel.
FEATURES—Unit has a spreader baffle for directing flames to sidewalls so that burner can easily be used with firepots of varying sizes. There are no projections beyond the housing and no exposed mechanism. Burner is completely enclosed so that control settings cannot be altered accidentally. By removing the burner cover, all parts are accessible.
MADE BY—*The Barton Co., Minneapolis, Minn.* 159

Thermostat

NAME—Mighty-Mite.
PURPOSE — Designed for service where a very small thermostat is required.
FEATURES—It is dust and waterproof and can be molded in rubber and plastics. Since the copper jacket has high thermal conductivity, unit is highly responsive to temperature. Unit has ⅛ in. cold headed, spun-in silver contacts which increase its life.
SIZES AND CAPACITIES—Standard model is designed for 300 watts, 110 volts or 150 watts and 220 volts.
MADE BY—*Mechanical Industries Production Co., 218 Ash St., Akron, Ohio.* 160

Solenoid Starter

NAME—Size 5 solenoid starter.
PURPOSE—Starting unit having a maximum rating of 100 hp at 220 volts.
FEATURES—Cadmium silver con-



tacts are used encased in arc hood. The switch has only one moving part. Wiring is made easy by labeled terminals. Unit is available with or without an enclosure. Makers claim that currents of at least 10 times the maximum horsepower rating are easily interrupted.
MADE BY—*Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.*....**161**

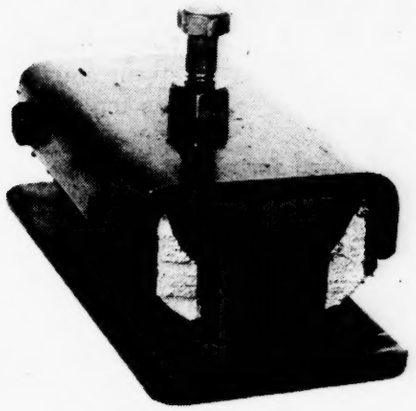
Airfoil Fan

NAME—Evans Airfoil fan.
PURPOSE — For use in mobile air conditioning, heating, and ventilating systems.
FEATURES—Unit is an axial flow fan molded from a heat resistant plastic.

Fan is designed for installations where a large amount of air circulation is required and where installation space and power source are limited.
SIZES AND CAPACITIES—Fans available in sizes from 2 to 14 in. diameter.
MADE BY—*Evans Products Co., 15310 Fullerton, Detroit 27, Michigan.* **162**

Vibration Isolator

NAME—RG unit vibration isolator.
PURPOSE — For dampening vibrations.



FEATURES — Unit is designed for load range of 50 to 250 lb. It attains maximum efficiency by a rubber-in-shear arrangement of a 5 in. rubber vibro-insulator. Unit is furnished with channel top member drilled and tapped, ready to receive a machine leg. Makers claim that the vibro unit has been used effectively for compressors, pumps, motors, and presses.
MARKETED BY — *Finn & Company, 2850 Eighth Avenue, New York, N. Y.* **163**

Stainless Steel Fittings

NAME—Tube Turn stainless steel welding fittings.
PURPOSE—Welded fittings of stainless steel to resist corrosion from atmosphere, acids and chemicals.
FEATURES—This line of fitting includes 180° long radius returns, 90° long radius elbows, 45° long radius elbows, straight tees, reducers, laterals, crosses, and flanges. Fittings available in 304, 347 and 316 stainless steel. Claims made for the stainless steel fittings are that they resist scaling at high temperatures, they are strong and ductile at sub-zero and elevated temperatures, they have long life, a clean appearance and resist corrosion from atmosphere, acids and chemicals.
SIZES AND CAPACITIES—¾ through 12 in.
MADE BY—*Tube Turns, Inc., Louisville, Ky.* **164**

September, 1946

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below, circle the item number of the equipment in which you are interested, using the number found at the end each item.

132	133	134	135	136	137	138	139
140	141	142	143	144	145	146	147
148	149	150	151	152	153	154	155
156	157	158	159	160	161	162	163
164							

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Abstracts and Reviews

BUILDING TRADES WAGES

A chart has been issued by the Builders Association of Chicago that lists the hourly wage rates paid building mechanics in 1937 of the principal cities of the United States and Canada.

It lists rates for the following trades: Asbestos worker, bricklayer-mason, carpenter, cement finisher, elevator worker, elevator construction, gas fitter, glazier, hoisting engineer, iron worker, common laborer, lathers, marble setter, mosaic and terrrazo setter, painter, plasterer, plumber, roofer, sheet metal worker, sprinkler fitter, stone cutter, and tile setter.

This chart, which has been issued since 1902, is widely used by architects and contractors.

1946 National Wage Chart. Price, $1.50. Published by Builders Association of Chicago.

ALUMINUM ALLOY SELECTOR

A slide rule type of chart, 8½ x 11 in., is used for presenting a large amount of technical information regarding 18 of the most widely used aluminum alloys. The alloys included are 2S, 3S, 14S, 17S, 18S, 24S, Pureclad 24S, 25S, 32S, A51S, 52S, R353, 56S, R361, R301, R303, Class R303, and R317.

Two slides are employed. One gives data on chemical composition, specific gravity, density, modulus of elasticity, coefficient of thermal expansion, thermal and electrical conductivity, specific heat, maximum forging temperature and heat treatment and annealing.

A second slide gives the tensile strength, yield strength, hardness and elongation for the sheet, plate, wire, rod bar, shapes, tubing pipe and forging of the respective alloys.

Alloy Selector. Reynolds Metals Co. Price, $1.

WELDING ALUMINUM

Latest practices and recommendations for joining aluminum by gas welding, arc welding, resistance welding, brazing and soldering, are described in a welding manual on aluminum.

Material on arc welding includes the metal arc, carbon arc, atomic hydrogen, and inert gas shielded processes. Resistance welding has sections on spot welding by four methods, seam and flash welding, and recommended machine settings. The book includes chapters on furnace and torch brazing, soldering, inspection of welds, and the metallurgy of welds.

Welding Aluminum. Spiral bound paper cover, 5½ x 8½ in., 88 pages. Published by Reynolds Metals Co. Price, $1.

RADIATION REFERENCE BOOK

Radiation requirements for steam and hot water systems with rooms of various sizes and window exposures, and with ceiling heights from 7 to 12 ft are given in the Beacon Radiation Reference Book and Heat Loss Guide. The book is designed as an aid to quick estimating of radiation requirements. The Btu method has been used in arriving at all heat loss calculations.

In the tables, allowances are made for sun-room glass exposures, exposed doors, unheated spaces, forced circulation hot water, northern and western exposures, rooms with fireplaces, insulated roofs, storm sash, weather-stripping, and design temperatures other than 0F to 70F. At the foot of each page containing data on a single room are given the additional steam and hot water radiation required if the room has top floor roof exposure.

Beacon Radiation Reference Book and Heat Loss Guide, by Edward Beckenstein. Stiff paper cover, 5¼ x 8 in. Published by Heating Publishers, Inc. Price, $3.

• • •

ATTIC VENTILATION CODE—A code which sets forth the basic requirements of satisfactory attic ventilation has been issued by the Propeller Fan Manufacturers' Association. It covers such important points as geographical variations in house structures, location of ventilating unit, type and characteristics of fan unit, air changes per minute, air velocities through grille and fan unit, attic discharge vents, fan housing and plenum chamber, protection against winter heat losses, electrical installation, and suggestions for installation and operation. For a free copy write to the Propeller Fan Manufacturers Association, 5-208 General Motors Bldg., Detroit 2, Mich.

PACKAGED FUEL—An exhaustive investigation was made by the Bureau of Mines into packaged fuel containing anthracite fines. The fuels studied were made at a commercial plant using the Glenn Smith process. The fuel was made from straight anthracite fines, and from blends of anthracite fines with bituminous coals as binders. Tests showed that packaged fuel made from anthracite fines alone tended to crumble excessively during burning and that from 30 to 50% of a caking coal may be essential in the mixture. For Report of Investigation 3882, Physical and Combustion Characteristics of Packaged Fuel Containing Anthracite Fines, write to the Bureau of Mines, Department of the Interior, Washington 25, D. C.

HEATING SYSTEMS—In "Automatic Heat for Real Living," a 56-page pocket size book in color, the layman has available information about the basic heating systems. The booklet points out the advantages of and applications for warm air, gravity and forced circulation, hot water, steam and other systems. It is intended to provide the heating trade with a booklet that will answer a number of the customers' questions regarding heating systems and how they function. Single copies are 50 cents; special prices in quantities for redistribution. Published by Surface Combustion Corp., Toledo 1, Ohio.

CORROSION OF STOKER FEED SCREWS—Results of tests conducted at Battelle Memorial Institute, Columbus, Ohio, on the subject of Corrosion of Feed Screws of Small Underfeed Stokers is available in Technical Report No. IX. The investigation was under the sponsorship of Bituminous Coal Research, Inc., and Calcium Chloride Association. The report covers the effect of moisture content of coal on corrosion, effect of acidity of coal, effect of reversal of gas flow and effect of calcium chloride treatment. Copies at 25 cents each may be obtained from Bituminous Coal Research, Inc., 912 Oliver Bldg., Pittsburgh 22, Pa.

COPPER WATER TUBE—Standard Specifications for Copper Water Tube (B 88-45) has been issued by the American Society for Testing Materials. They cover such points as dimensions and weights, tolerances and testing. Copies at 10c each may be obtained from the society, 1916 Race St., Philadelphia 3, Pa.

PIPE THREAD STANDARDS—The American Standard on Pipe Threads, B2.1-1945, is available from the American Standards Association, 70 E. 45th St., New York 17, N. Y., at $1.50 per copy. These standards were sponsored by the American Gas Association and the American Society of Mechanical Engineers to answer a number of questions asked by industry regarding pipe threads.

AUTOMATIC CENTRAL HEAT—The objective of this 13-page illustrated booklet is to acquaint the home owner with the advantages of automatic central heat. It describes and illustrates automatic central heating with warm air, hot water, vapor or steam. It also discusses heating with coal stokers, oil burners, and gas burners. For copies, 25 cents each, write Indoor Climate Institute, Penobscot Bldg., Detroit 26, Mich.

TESTING AND RATING CONVECTORS—Recommended Commercial Standard for Testing and Rating Convectors has been issued by the National Bureau of Standards as TS-4169. The standards cover definition, requirements, and methods of testing and rating cast iron and non-ferrous steam and hot water convectors, and a means for checking convector ratings for approval.

PIPE NIPPLES—Standards for "Pipe Nipples—Brass, Copper, Steel, and Wrought Iron," known as CS5-46 have been accepted by the industry and copies are available at 5 cents per copy from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. The standard covers steel, ferrous-alloy and wrought iron pipe nipples, black and zinc coated in iron pipe sizes from ⅛ to 12 in., and brass and copper nipples in standard sizes from ⅛ to 6 in., inclusive.

HOME INSULATION—As part of its growing series of pamphlets on "Facts You Should Know About—", the Educational Division of the Better Business Bureau has published a 16-page booklet on Home Insulation. Written for the layman, it discusses the purpose of insulation, insulating material, installation and application, vapor barriers, and costs.

HEATING FOR THE LAYMAN—The Answer Book on Home Heating, a 26-page booklet illustrated in color, has been issued by the General Electric Co., 5 Lawrence St., Bloomfield, N. J., to explain to the layman the various heating systems that are available, and how they function. It includes general information on the heat pump, and summer cooling. For a copy, write to the address given.

RIVETED JOINTS—Studies were made at the Engineering Experiment Station of the University of Illinois by W. M. Wilson and A. M. Ozelsel on the strength of riveted joints in copper sheets. The tests described in Bulletin 360 were made to determine failure by tearing out of rivets to the edge of sheet; by shearing of the rivets; by the bearing pressure of the rivets against the edge of the holes in the sheet, and by tension failure of the sheet between the rivets. In addition tests were made to determine the rivet pattern upon the strength of the sheets. Bulletin free by writing the Engineering Experiment Station, University of Illinois, Urbana, Ill.

WATER HEATERS — Model specifications for the installation of wiring and plumbing for automatic electric storage water heaters has been issued by the Edison Electric Institute as E.E.I. Publication No. 4. These specifications are assembled only as a guide and are not intended as recommendations. For copies at 25 cents each, write to Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y.

SMOKE PREVENTION — Bituminous Coal Research has issued Technical Report No. VII of 24 pages on Application of Overfire Jets to Prevent Smoke in Stationary Plants. It discusses the design and construction of blower jets and devotes considerable space to jet locations. Overfire jets force air into the furnace where it is needed to mix with the unburned gases. In this way, the smoke problem is attacked by preventing smoke. However, if operated unnecessarily, the overfire jets are wasteful, and they will increase the heat loss in gases leaving the boiler. For copies, 25 cents each, write to Bituminous Coal Research, Inc., 912 Oliver Bldg., Pittsburgh 22, Pa.

NEWS OF THE MONTH

HEAT PUMP

Sporn sparks program to unite utilities in reverse cycle tryouts.

A series of regional "Heat Pump Meetings" among key men in electric light and power companies is implementing a program proposed by Philip Sporn, Executive Vice President of American Gas and Electric Service Corp., to further the development of the heat pump as applied to all-electric, year-round, house heating and cooling and domestic water heating.

• **THE IDEA.** — More than 15 years of working and preaching for the heat pump were behind Mr. Sporn's proposal, in April of this year, that the business managed electric utilities throughout the United States join in a real effort to encourage manufacturers to develop packaged heat pump units that could be manufactured on a production basis and sold at realistic prices. Mr. Sporn has developed tentative specifications for such units and hopes to secure commitments by utilities for the purchase and trial of 1000 air.conditioning and house heating units and 10,000 water heating units, all of which would use the reverse cycle heat pump principle.

• **MEETINGS.** — To make his plan effective, to enlist the active cooperation of utilities, to mull over specifications and possibilities, and to arrive at a sound basis for inviting bids from manufacturers, a series of regional "Heat Pump Meetings" was planned. The first meeting in June was sponsored by and held in the New York offices of the American Gas and Electric Service Corp. This first meeting was attended by representatives of electric companies from the northeastern, middle Atlantic, and north central states.

At a second meeting held in Birmingham, Alabama, on August 5 and 6, some 60 representatives of electric light and power companies in 17 southern states were present to hear and discuss Mr. Sporn's proposals. This meeting was sponsored by the Southeastern Electric Exchange.

• **SPECIFICATIONS.**—The specifications being developed for the heat pump contemplate an automatic, electric motor driven unit which will serve the double purpose of cooling in summer and heating in winter for homes and commercial establishments. Regional variations in requirements will probably result in trial of different modes of heat transfer such as an air-to-air unit now in production, an earth-to-water installation on trial in Indiana, water-to-air units for regions where constant temperature water is plentiful and winter air temperatures are low.

The primary reason for the offer to purchase a large quantity of the units specified is to enable the manufacturer to devote a substantial amount of time and research in development of a device having six basic qualities:

(1) High reliability,
(2) Economical performance,
(3) Reasonable first cost,
(4) Low operating cost; the unit must be highly efficient and subject to inherently low maintenance cost,
(5) Compactness,
(6) Neat appearance.

Mr. Sporn has found that a number of manufacturers are interested in the production of equipment and, at the meetings already held, many of the electric companies attending have expressed a willingness to join in the program and to purchase and install experimental units when they have been produced.

SUCCESSOR

Guy Panero buys Clyde Place engineering firm.

Guy B. Panero, internationally-known engineer recently cited by the War Department for a special mission investigating new chemical processes in Germany, has purchased the firm of Clyde R. Place, Consulting Engineers, Graybar Building, New York City, and is now directing the organization under the name, Guy B. Panero, Successor to Clyde R. Place, Consulting Engineers.

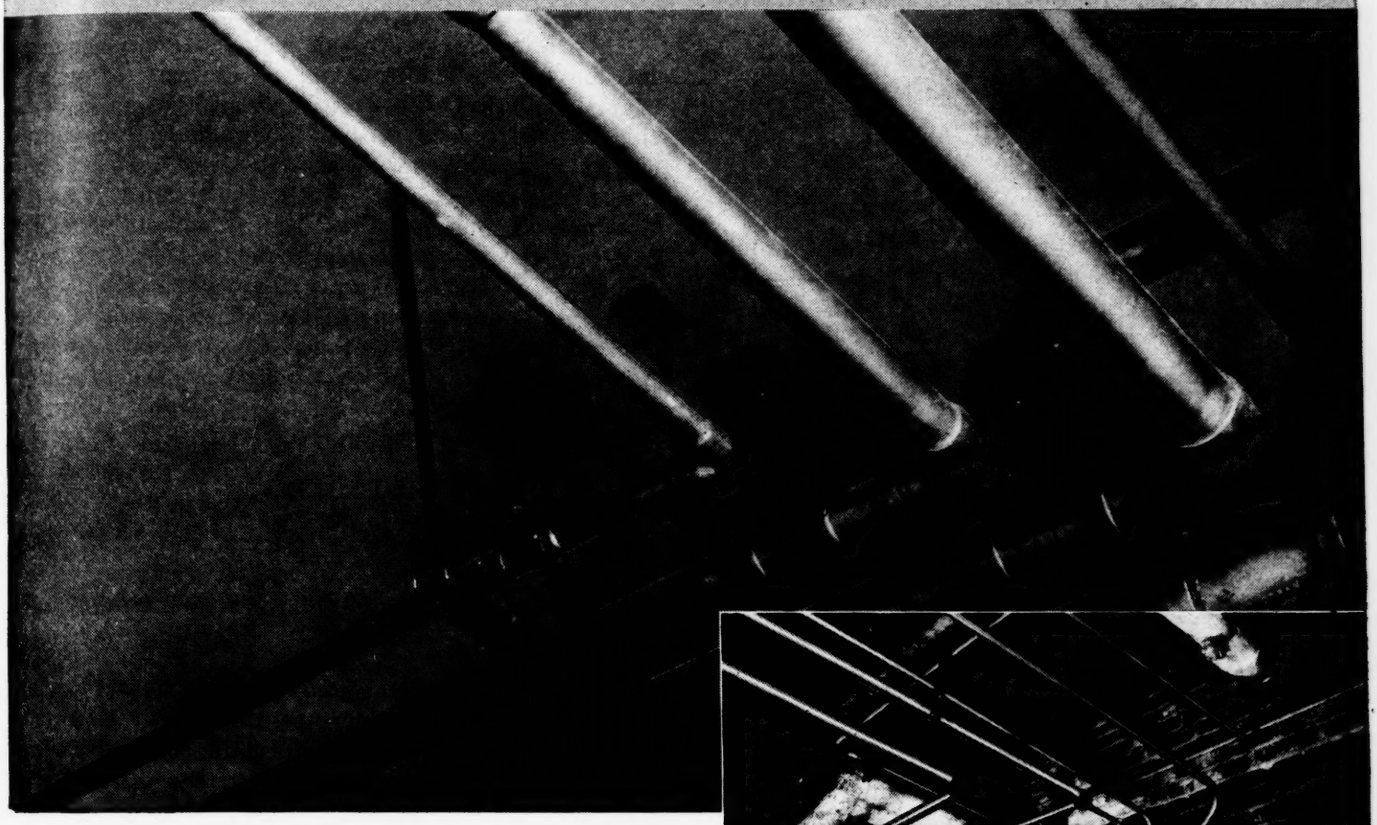
• **EXPERIENCE.**—Mr. Panero has been engaged in engineering and building activities since 1925 both here and abroad. Before going to Germany, where he remained for five months, he was chief engineer in charge of the entire program for several large industrial facilities, among them the $42 million Wolf Creek Ordnance Plant at Milan, Tenn., and the $20 million Gulf Ordnance Plant at Aberdeen, Miss. He was construction manager for synthetic rubber plants at Baton Rouge and Lake Charles, La.

G. Panero

In addition to his experience in the industrial field, Mr. Panero has also worked extensively in institutional and commercial building. He served in an engineering capacity with the constructors of the Rockefeller Center development and his work in Europe includes the American Embassy and Maison Internationale at Cite 'Universite' in Paris; Earl's Court in London, and industrial and residential projects in Brussels, and Milan, Italy.

• **ORGANIZATION.**—The organization which Mr. Panero has taken over has been one of the most active engineering firms in the New York area. Under the management of the late Clyde R. Place, who died on March 28 (H&V:5:46:p120), its projects included Rockefeller Center, the Waldorf-Astoria Hotel, the Graybar Building and numerous other structures in all parts of the United States as well as abroad.

NO JOB IS TOO SMALL...OR TOO LARGE... FOR COPPER



COMPARE the cost of Revere Copper Water Tube, *completely installed,* with that of other materials — and it is clear that you can give your customers lasting value in heating and water lines, and still make attractive profits for yourself. This applies to a modest residential job as it does to a large business building.

Revere Copper Water Tube (99.9% pure copper) is seamless, and is cold drawn with a gun-barrel finish inside. It is deoxidized and is free from flaws and blemishes. Joints are made with either soldered or compression fittings.

Made for water supply, heating, air conditioning and other services in all types of buildings, this tube is stamped with the Revere name and the type at regular intervals. Look for these identification marks—they insure full wall thickness and the close gauge tolerances essential for tight sweated joints.

In making your plans you can specify or install such long-lived Revere materials as Copper Water Tube and Red-Brass Pipe; Sheet Copper for tanks, ducts, pans and trays; Sheet Herculoy for tanks; Dryseal Copper Refrigeration Tube (dehydrated and sealed); Copper oil burner, heat control and capillary tubes.

Revere materials are handled by Revere Distributors in all parts of the country. The Revere Technical Advisory Service, Architectural, is always ready to serve you. Call your Revere Distributor.

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PIPE LINES

Three companies unite to pipe natural gas from Texas to Los Angeles. FPC bars N. Y. lines.

The Federal Power Commission has authorized Southern California Gas Co. and Southern Counties Gas Co. of Los Angeles to join with the El Paso Natural Gas Co. of El Paso, Tex., in the construction of a $70 million gas pipeline from the Texas Panhandle to Los Angeles.

In issuing the order, the FPC upheld the claims of the two Los Angeles gas utilities, which were supported by testimony given by Los Angeles and San Francisco city officials and Chambers of Commerce representatives, that the increasing industrial and domestic demand for gas for factory processing and home heating and cooking purposes in the Los Angeles area makes it necessary to supplement an indicated deficiency in California gas supplies with out-of-state supplies.

• **TWO PROJECTS.**—The FPC order authorized the three utilities to construct an interconnected system of pipelines totaling 1200 miles in two major projects.

In one project, Southern California and Southern Counties (with state authority previously obtained from the California Railroad Commission) in mid-July issued initial contracts for preliminary work on a 214-mile, 30-in. pipeline extending from Blythe, Calif., on the west bank of the Colorado River, to the Santa Fe Springs Station of the Pacific Lighting Corp., parent company of the two utilities, ten miles east of Los Angeles.

This line will lie entirely within California. It will traverse the full length of Riverside County and portions of Orange and Los Angeles counties. The plans call for a pipeline designed for 52,000 MCF per day of line-pack storage in addition to delivery capacity of a maximum of 305,000 MCF of gas per day. Southern Counties and Southern California Gas Co. will also erect a 10,000 hp compressor station at Blythe. The California portion of the project will cost an estimated $16,225,000.

The other project is a pipeline to be constructed by El Paso Natural Gas Co. and will consist of 737 miles of 26-in. diameter pipe extending from Eunice, Lea County, New Mexico, to a connection with the 30-inch line at Blythe. Connecting facilities embraced within the El Paso Co.'s project include a 250-mile extension of 24-inch line from Dumas, Tex., to a plant operated by the company at Eunice; a system of compressor stations with a total of 129,800 hp capacity, spotted at various points along the line; five connecting lateral lines in the Permian Basin gas fields of western Texas and southeastern New Mexico; three gas purification plants and a dehydration plant.

Cost of the El Paso Co.'s portion of the project is estimated at $53,800,000, and of the total project, $70,025,000.

• **THREE STAGES.**—Construction is scheduled to proceed in three progressive stages. Initial deliveries of gas to the Los Angeles companies is due to begin about June, 1947. Route surveys and preliminary incidental work has already been started, but major construction is not expected to get underway until December or January.

• **N. Y. STATE.**—In an action dated August 6, the Federal Power Commission dismissed the application of The Central New York Power Corporation to expand its natural gas facilities in New York State. (Docket G.120 and G.702)

The natural gas company had petitioned for permission to supply the Syracuse, Oswego, Utica and Watertown areas with straight natural gas. If granted this would have resulted in the immediate material expansion of gas house heating over a substantial area in central New York State. The action was therefore opposed by various interests including Anthracite Institute, nineteen railroads, Syracuse Coal Exchange, and the Utica and Tri-County Coal Associations.

In dismissing the application, the Federal Power Commission said in effect that the gas company had failed to prove that the construction and operation of the new facilities "are or will be required by the present or future public convenience and necessity."

FOUNDRY HEALTH

Ventilation is important part of program in employee welfare.

Two years ago the Ferro Machine and Foundry Company decided to do something about adequate ventilation, not only for their machine shop and office areas but also for the workmen in the dirtiest and hottest part of the foundry, the metal pouring zone.

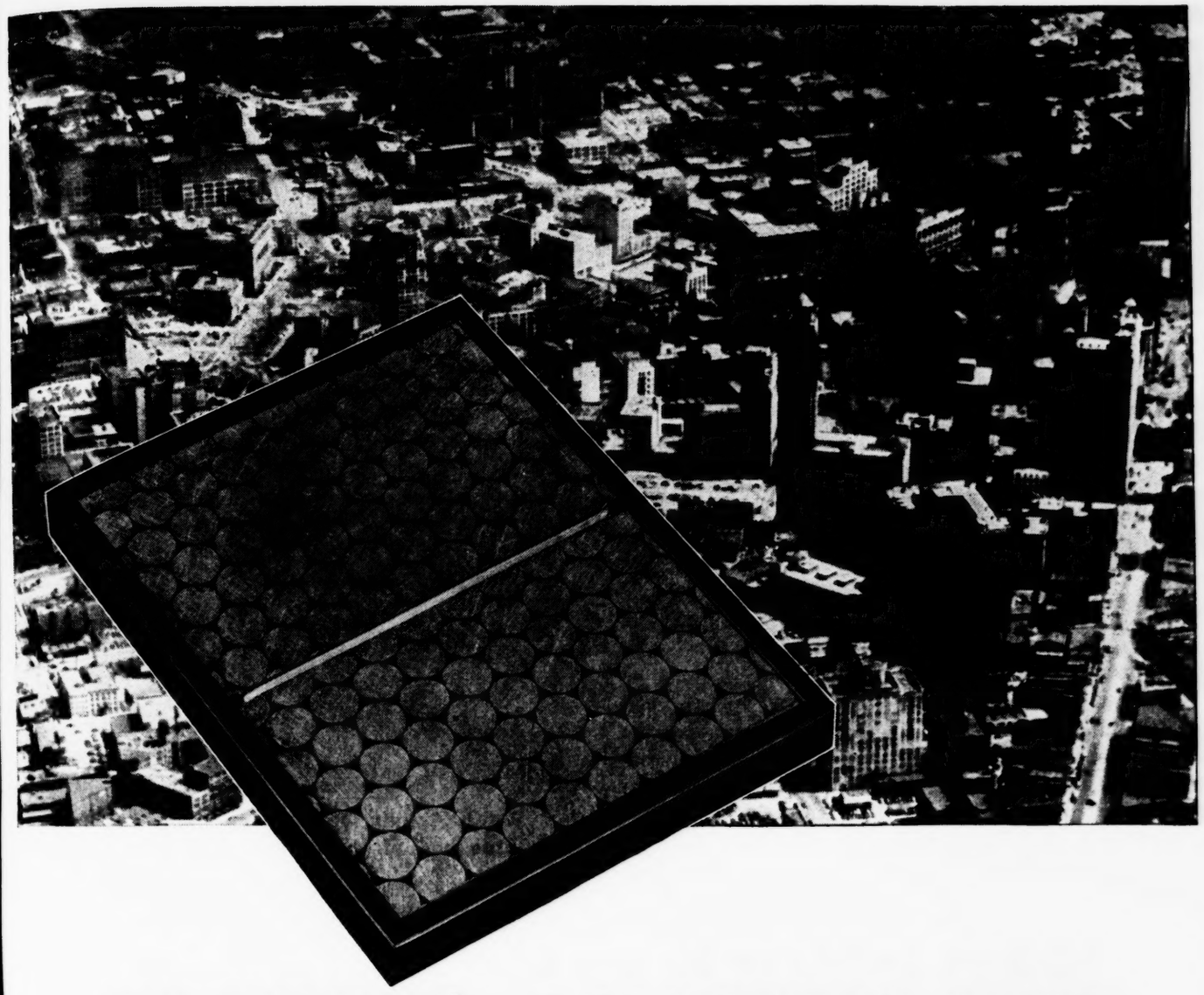
• **METHOD.** — An engineering firm began studying how to pull out 656,000 cu ft of dust-laden, hot air per minute and deliver a like amount of clean cool air to an employee handling a ladle full of molten iron. Winters in Cleveland are such that outside air cannot be pumped into a foundry without being preheated.

Part of the problem involved selling employees on the idea that removal of standing fans which delivered a constant blast of churned up dirty hot air on their backs would not seriously jeopardize their health. Up to that time the fans had been regarded as the last word in foundry air conditioning.

• **SOLUTION.** — All production lines were hooded, starting with the zones where molten iron was poured from ladles into moulds. Hoods were not needed around the cupolas since little dust is present there. To rid the area of excess heat, drafts were installed through which the heated air could escape through roof vents.

To heat supplied air, Ferro rebuilt the steam plant. While the results have not been all that Ferro's president, John M. Price, had hoped for, it has been successful to the point where the air is now dust free and at a much lower temperature than would ordinarily be found in a foundry.

• **REACTION.**—Workmen readily agreed that ridding



YOU, DUST-STOPS* and the COMMERCIAL MARKET ...can be a profit-winning combination

Managers of most commercial establishments know that filtered air is an important business asset. Many of them know, from experience, that clean air can be obtained at both low initial *and* low maintenance costs with DUST-STOP Air Filters.

The DUST-STOP is a replaceable-type air filter. Packs of adhesive-coated FIBERGLAS fibers provide an efficient medium for catching and holding most atmospheric and manufactured dusts.

DUST-STOP Air Filters are adaptable to the smallest and the largest commercial and industrial heating, ventilating and air-conditioning systems. They may be installed in custom-built or the complete, ready-to-assemble DUST-STOP steel frame cells. These cells can be built up into filter banks *to handle any cfm of air required.* Once the filter bank is installed, maintenance is easy and economical—for replacement DUST-STOPS are readily available from authorized suppliers in nearly every community.

Complete information on DUST-STOP Air Filters will be sent on request. Write for 24-page illustrated booklet—"Air Filtration in Central Systems" (A5.2.1), Owens-Corning Fiberglas Corporation, Department 912, Toledo 1, O. Branches in principal cities.

In Canada, Fiberglas Canada Ltd., Toronto, Ontario

DUSTOP

*T. M. Reg. U. S. Pat. Off.

AIR FILTERS

—a FIBERGLAS product

the air of dust and smoke was the most valuable result of Ferro's expenditure of almost a quarter of a million dollars in its air handling program.

Of interest to management was the reaction of employees to its modernization efforts. First noticed was the reduction in turnover of help. While a 20% turnover is fairly common in the foundry industry, Ferro finds that its turnover is no more than 6%—in spite of frequent layoffs in recent months because of shortages of material. This compares with Ferro's turnover of 12% per month during the war.

It is also noted that a higher type of workman is being attracted by the improved conditions.

• **X-RAY.**—The point must be noted, however, that all of Ferro's improvements have not been in the line of air conditioning. Recently the company spent more than $20,000 to install a complete X-ray laboratory in its Cleveland plant. Purpose of the installation was to screen applicants who might be subject to tuberculosis or silicosis. Installation of the free lung testing for all employees was welcomed by employees and union officials.

• **LEGAL ASPECTS.**—Silicosis has been classified by the Ohio Industrial Commission as an occupational disease among foundry workers. Therefore, a foundry which reports a worker disabled because of silicosis finds itself under Ohio's laws paying the disabled employee not only $24 per week for the rest of his life but is also tagged with a $7,500 death benefit to his estate. Of the foundry's 1500 applicants for jobs since March 1st, 1% were found susceptible to silicosis.

• **ECONOMY.**—The marked reduction in Ferro's turnover and in absenteeism has resulted in a scrap loss well below the average of 15%. Both management and labor regard the company's present scrap loss of 7% as too high, and a 5% loss is predicted when material supplies are stabilized.

STANDARD SYMBOLS

Nomenclature standardization committee to quiz refrigeration industry.

In connection with the effort to standardize abbreviations, graphical and letter symbols used by the air conditioning and refrigeration industry, the ASA Nomenclature Committee B53, sponsored by the ASRE (H&V:8:46:p110), is endeavoring to find out just what is now being used by the industry.

• **QUESTIONNAIRE.** — It was felt by the committee personnel that the best way to achieve standardization of various abbreviations and symbols was to obtain from the industry samples of what are now being used, carefully study and compare them, and then to select the best ones as standards.

Accordingly, the Committee is writing a letter to two hundred representative firms engaged in refrigeration and air conditioning, asking them for the following information:

1. What graphical symbols do you use in representing refrigeration equipment within the refrigeration cycle?
2. What letter symbols do you use?
3. What abbreviations do you use?

The scope of the inquiry is limited mainly to nomenclature used in the refrigeration cycle because of the very complete sets of standards already adopted for allied industries and professions such as electrical, mechanical, hydraulics, and piping. Appropriate selections of these standards will be included in the final report of the Committee.

• **INVITATION.** — While the recipients of the letter were selected as being representative of the industry, the inquiry is by no means limited to them, and the committee hopes that any firm or individual that is interested, whether or not they receive a letter, will send in a set of symbols and abbreviations they use together with any suggestions they may care to offer. Communications should be addressed to D. F. Hayes, Secretary, Nomenclature Committee B53, American Standards Association, 70 East 45th St., New York 17, N. Y.

TUNNEL FANS

25,000 tons of air per hour to ventilate Brooklyn-Battery Tunnel.

Fifty-three giant fans, capable of supplying and removing hourly 25,000 tons of air, will ventilate New York City's Brooklyn-Battery Tunnel when it is completed. These fans, when operating at full speed, will be capable of completely changing the air in the tunnel every one and one-half minutes.

• **CONSTRUCTION.**—Contract to build the ventilating equipment has been awarded by the Triborough Bridge & Tunnel Authority to B. F. Sturtevant Company Division of Westinghouse Electric. Production of the fans will begin at Sturtevant's plant at Hyde Park in the near future. More than 100 electric motors needed to drive the fans will be built at the Westinghouse plant at East Pittsburgh, Pa.

Construction of the tunnel was resumed last November after nearly three years interruption brought on by wartime shortages. When completed, its twin tubes, 31 ft in diameter and one and three-quarters miles long, will constitute the longest underwater ventilated vehicular tunnel in the United States.

• **DESIGN.**—The ventilating system was designed by the Triborough Bridge & Tunnel Authority, under direction of Mr. Ralph Smillie, chief engineer, and Herbert G. Cruthers, mechanical engineer.

Twenty-seven supply fans, delivering air through openings near the floor of the tunnel roadway, and twenty-six exhaust fans, drawing through vents in the ceiling, will maintain a continuous upward flow of air. The fans will be installed in buildings to be constructed at Battery Park, off Governors Island in New York Bay, and in Brooklyn.

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Bankers concerned with real estate and its management almost invariably advise cast iron for new boilers or for replacement. Experience has taught them good reasons why cast iron is a sound investment . . .

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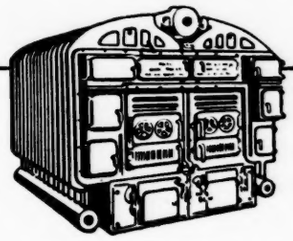
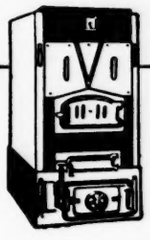
Bankers who know cast iron also know the superiority of H. B. Smith Cast-Iron Boilers for every use—in business, industry, institutions and homes. Plan to use them for every new building, every replacement. Write for your free catalog.





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ANIMAL SHELTER

Research conference at Missouri enlists industrial, engineering, and agricultural resources.

Lack of the needed information has led to costly mistakes in the fabrication of farm buildings by industry, to excessive expenditures by farmers, and to huge losses in production, according to Dean E. A. Trowbridge of the Missouri College of Agriculture speaking to a group of farm structures engineers and representatives of the building industry at Columbia, Missouri. The representative of one large fabricator at the Columbia meeting stated that only recently his company had spent a considerable sum in trying to work out designs for buildings to be prefabricated for use by farmers—only to conclude that at present there was not enough information to enable the company to produce buildings it could stand behind. The company has therefore dropped the project at least temporarily.

There has, however, been no lack of designs; in fact, it was brought out at the conference, for example, that there are now more than 500 different designs of poultry houses available to farmers in the United States. That example indicates some of the confusion that exists.

• **SOME QUESTIONS.**—It was brought out at the conference that when engineers begin designing dairy buildings, for instance, they encounter problems on which basic information is lacking. The question of prime importance is, of course, the relationship of milk production to feed consumption. What, for example, constitutes comfort for the dairy cow? At what temperature can she be expected to produce most efficiently? Is humidity a factor in milk production? What constitutes a draft on a dairy cow? What is the effect of wall temperature in a warm climate? In a cold climate? What effect do different wall surfaces, color or textures, have on radiant heat loss from the animal? What is the effect of condensation on the walls and ceiling? What is the optimum space that should be allowed within the barn for each cow? How much and what kind of ventilation should be provided?

• **NEW LABORATORY.**—The research will be conducted by the Missouri Agricultural Experiment Station at Columbia in cooperation with the USDA agricultural engineers in a new laboratory now under construction. Footings and foundations for the new laboratory are already in place. The project will be called a Psychroenergetic Laboratory to signify its concern with problems in humidity and metabolism. The laboratory will consist of two insulated test rooms or chambers enclosed in an insulated building. Each chamber will accommodate six dairy cows.

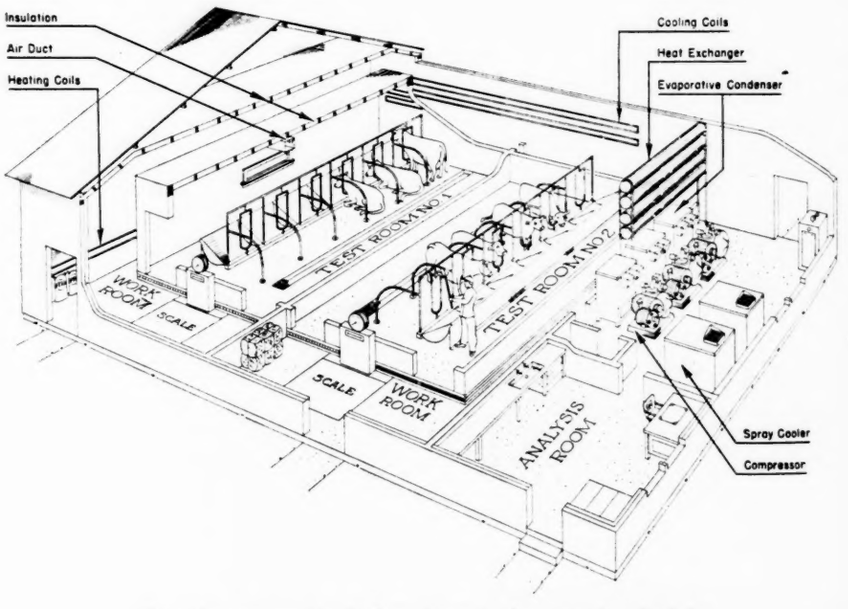
The barn or outer structure of the laboratory will be 40 x 60 feet in size. Air-conditioned space will surround the inner test rooms where temperature can be maintained within 5F or less of the temperature of the test under way. Loss of heat through the walls of the test room will thus be minimized.

The equipment and controls will supply air to the laboratory at a given temperature and humidity, and are expected to maintain the desired temperature in the room with fluctuations of 1F or less. Condensing coils will be placed in the room to pick up part of the moisture emitted by the animals and to assist in keeping the room at an even temperature. Because of the large fluctuations in outside temperatures, the air-conditioned space surrounding the test rooms will be equipped with both cooling and heating coils. Inasmuch as the heat produced and the moisture emitted by the animals is to be measured, the control devices for the air-conditioning machinery and the cooling coils must be accurate and sensitive.

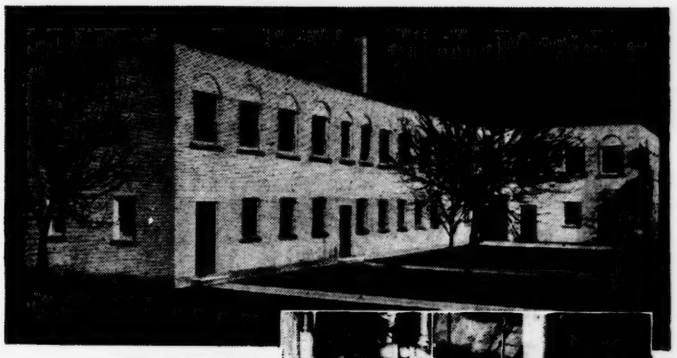
In addition to the test rooms and the surrounding air-conditioned space, the laboratory will also contain an analysis room. At the present time no provisions have been made for collecting feces and urine, but it is considered highly probable that as the investigations progress it may appear desirable to broaden the work to include nutritional studies. Consideration is therefore being given to alteration of the plans to include pits to facilitate the collection of these materials for analysis should this become necessary or desirable.

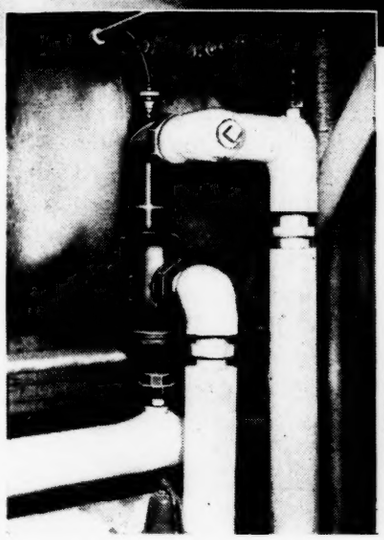
• **COST.**—Cost of the project is estimated at from $140,000 to $250,000, depending on the time needed to complete the work.

• **COMMITTEE.**—At the Missouri Station the direction of the project is under a committee consisting of



Psychroenergetic Laboratory to be constructed by Missouri College of Agriculture and USDA.





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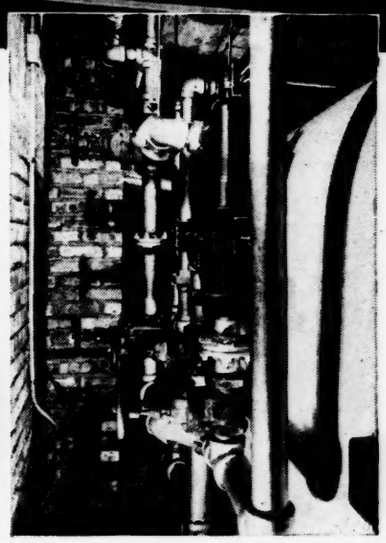

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Here is a new all-mechanical modulating hot water control that is providing the exacting perfection required in hospitals and institutions and yet is low enough in cost to be a good investment for the smaller homes.

It anticipates temperature changes, modulates with low radiator temperatures and has no cold seventies and no lost heat or discomfort in mild seasons.

Water circulation is continuous, and boilers are not subject to the injurious effects of "on and off" controls. It saves as much as 25% on the fuel and cuts installation costs because smaller radiators and pipes can be used and because Sarcotherm control is all mechanical, low in cost and easy to install

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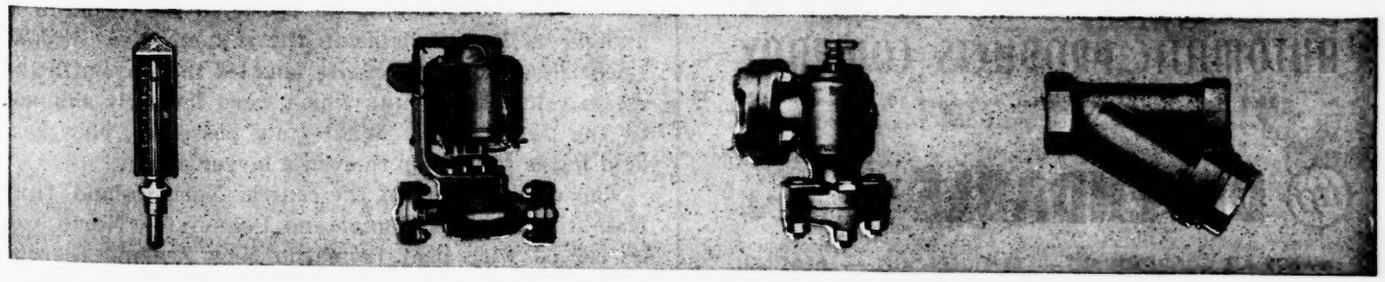

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News of the Month

S. Brody, Department of Dairy Husbandry, Chairman; J. C. Wooley, Department of Agricultural Engineering; A. C. Ragsdale, Department of Dairy Husbandry; L. A. Weaver, Department of Animal Husbandry; A. G. Hogan, Department of Agricultural Chemistry; H. L. Kempster, Department of Poultry Husbandry; and E. A. Trowbridge, Director of Missouri Station. The engineering studies are under the immediate direction of Professor J. C. Wooley. The resident engineer on the project for the Division of Farm Buildings and Rural Housing of the USDA agricultural engineering group of the Bureau of Plant Industry, Soils, and Agricultural Engineering is H. J. Thompson. J. R. McCalmont, also of the Division of Farm Buildings and Rural Housing in charge of animal shelter research projects, will represent the BPISAE in Washington. The study of the physiological reactions of dairy animals is under the direction of Professors S. Brody and A. C. Ragsdale. The representatives of other departments of the Station will assume responsibility as investigations may be conducted with other classes of farm animals.

VOLCANIC HEAT

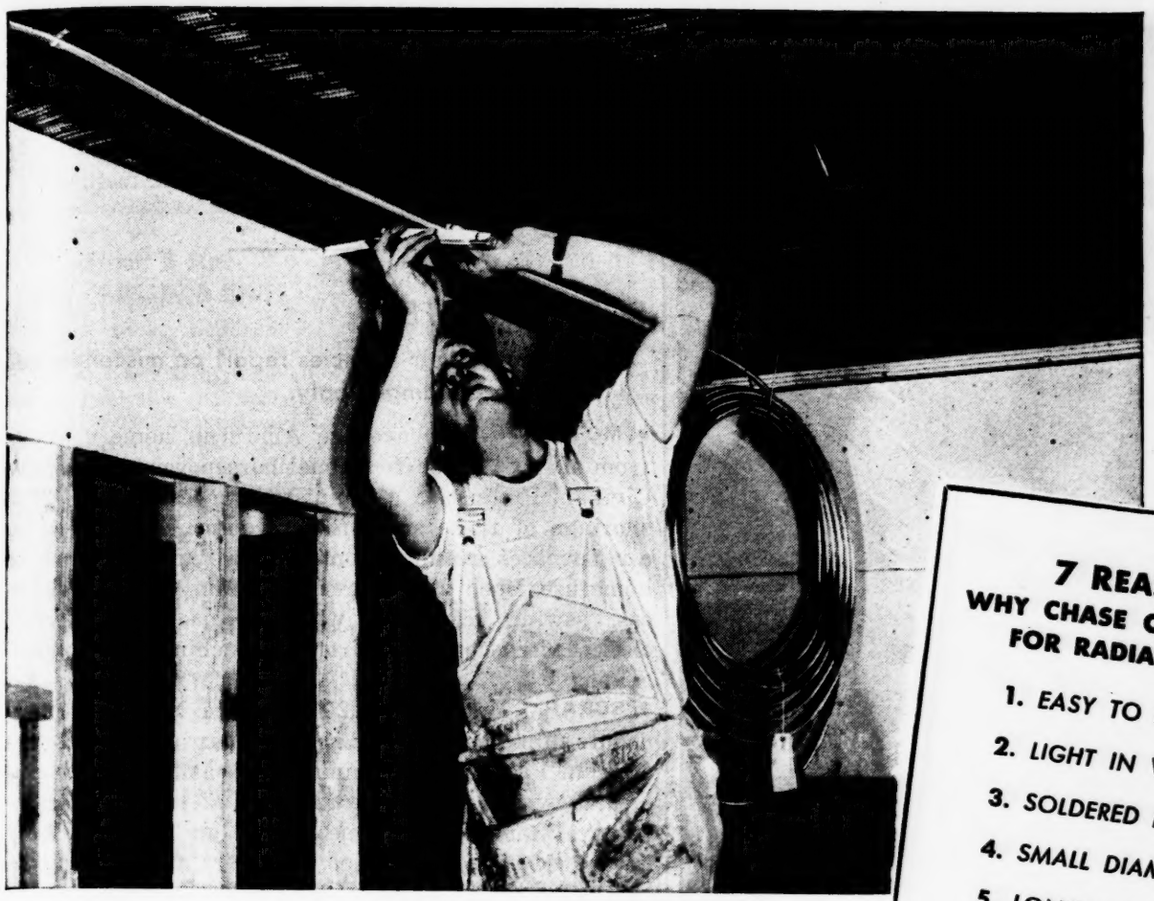
New Zealand planning to harness thermal regions as heat source.

The first phase of New Zealand's plans to harness the enormous powers of its Rotorua thermal region to develop heat and power is undergoing thorough tests by scientists at the so-called "volcano observatory."

• **RESOURCES.**—Built by the Department of Scientific and Industrial Research, according to a special article from the Wellington, New Zealand, correspondent of the Christian Science Monitor, the observatory is engaged in studying the future possibilities of the thermal area and its possibilities for industrial development. The 300-mile expanse of lakes, geysers, boiling mud pools and hot springs includes waters containing sulphur, alkali, calcium carbonate, salt and iodine waters, steam holes and hot air vents. They especially want to know what can be done with the heat and steam, for New Zealand is short of coal for railways and gas plants, having depended upon Australian coal, which was cut off largely during the war.

• **HOT MOUNTAIN.**—"If we can find a way to utilize the heat from Mt. Ruapehu alone, we would not need coal," says Montague Ongley, government geologist, who is supervising the work of the new volcano laboratory, which is also measuring rainfall and earth movements and seeking to estimate just what heat and power are available in the region. New Zealand scientists admit that the Italians led the way, utilizing steam vents in Tuscany which were formerly shunned by the people there. What Italy possesses, New Zealand hopes to develop to even a larger extent.

The whole region of the central North Island, from Hamilton down to Napier and Palmerston North, can be served with heat from the New Zealand thermal



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...build prestige with Chase Copper Tube

FOR the radiant heating system, with its panel coils, copper tube is a "natural." It can be bent easily to shape—the tools needed to install it are few and familiar. It is handy to work with in the preferred ceiling-type installations, since diameters may be as small as ½" and ⅜".

These are some of the on-the-job advantages. You profit again—in customer goodwill, greater prestige, and more business—from the *long-range* results of installing Chase Copper Tube for radiant heating. Being resistant to corrosion, it is durable, long-lasting. And this operating economy is something home-owners will appreciate—and will *remember*.

The demand for Chase Copper Water Tube is so great that we are not able to satisfy it at all times. However, the technical information is now available to you for future planning. Send today for a complimentary copy of our book, "Copper Tube for Radiant Heating." Simply write, on business letterhead, to Dept. HV 96.

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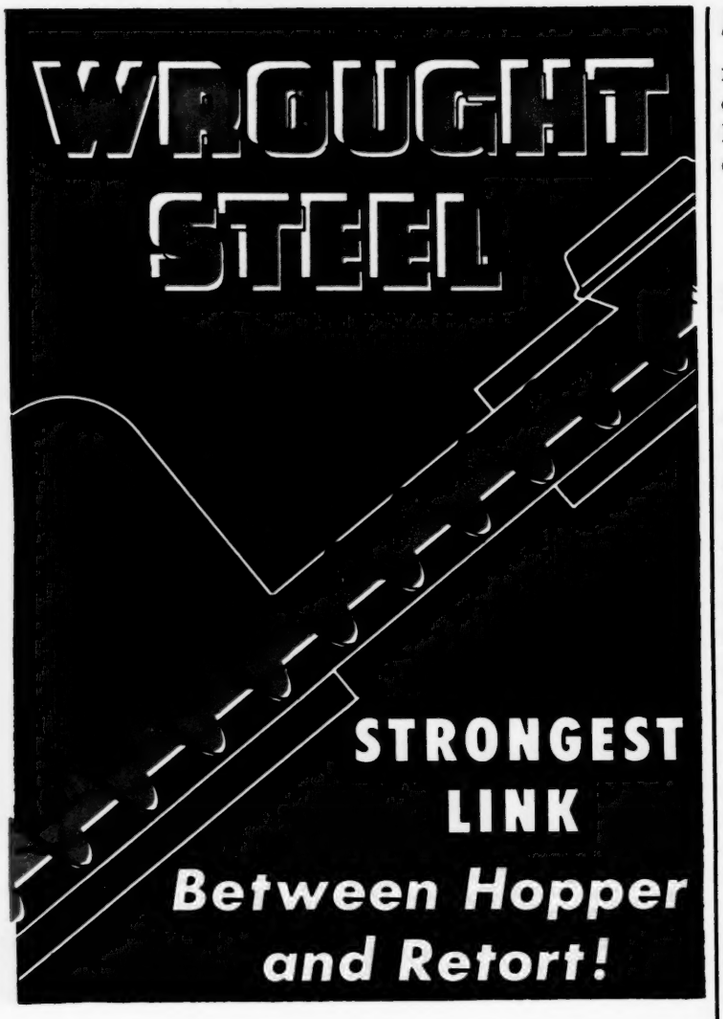

The Crown Stoker Feed Screw

Rugged dependability that lasts—year after year an unbreakable link between hopper and retort. That's the Crown *wrought steel* stoker feed screw. This tough, wrought steel screw, continuously welded, possesses a definite grain structure, grain that accents strength where it is most needed, grain that resists the wear of constant use. Then, too, you'll find far less coal degradation using smoother surfaced wrought steel. If you want top equipment for your stoker, you'll find the Crown wrought steel stoker feed screw ideal.

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regions under existing techniques, according to officials of the Department of Scientific and Industrial Research. Carriage of heat beyond those points will depend upon the improvement of present methods.

SUPPLY NOTES

CPA and other agencies report on miscellaneous items in building supply.

• **MOTORS.** — The average American home contains from six to a dozen fractional horsepower motors, the Civilian Production Administration estimates. The shortage of these small motor components for warm air furnaces results from their diversion to other home uses such as refrigerators, fans, vacuum cleaners, sewing machines, washing machines, electric clocks, kitchen mixers, ironing machines and phonographs.

• **SCRAP.**—More than 1,200 obsolete Navy and merchant ships will be scrapped under a plan of the Civilian Production Administration and other government agencies to provide iron and steel scrap for industry. Some of this metal will go into plumbing fixtures, cast iron soil pipe, radiators and other home building materials and equipment.

• **INSULATION.**—Additional annual output of 100 million square feet of structural insulation board is expected this year as the result of expansion of existing facilities and establishment of a new plant, according to the Civilian Production Administration. June production of structural insulation board was approximately 175 million square feet, according to OPA. This was about 8 per cent over May output.

• **ASPHALT.**—Asphalt roofing and siding shipments totalled approximately 6½ million squares in June, the highest level in the industry's history, the Civilian Production Administration reports. Anticipated further improvement in production in the last half of this year will bring supply into approximate balance with new construction and maintenance requirements.

• **RADIATORS.**—Mechanization of two cast iron radiation plants, completed in August, will increase national production of cast iron radiation by about 30,000 square feet a month, the Civilian Production Administration says. The monthly rate of cast iron radiation production in May, June and July for the nation exceeded 3 million square feet, more than double the average monthly rate in the last half of 1945.

• **PIPING.** — Surplus valves and pipe fittings, which originally cost the government nearly $100,000,000, are offered to all classes of purchasers including priority claimants, in a new national sales program, War Assets Administration announced in August. The inventory includes commercial, industrial, Navy, maritime and other special types of valves and pipe fittings. The Navy types include many items that are adaptable to industrial and commercial piping applications. All sales will be conducted by WAA's 33 Regional Offices, and prospective purchasers are invited to inspect the inventories.

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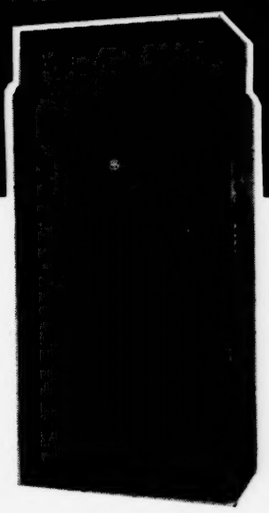

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All-purpose, handsomely designed, smooth functioning air conditioning units with all copper condenser and liberally designed coils—removable outlet box for use with duct system—removable panel in back of outlet box for additional grills where front and back air distribution is desired in center of room . . . two way adjustable deflecting grill . . . knock-out for fresh air connection . . . removable one-piece panel in front for easy accessibility. The cabinets are made of furniture steel . . . crackle finish. Also available with one or two row heating coil.

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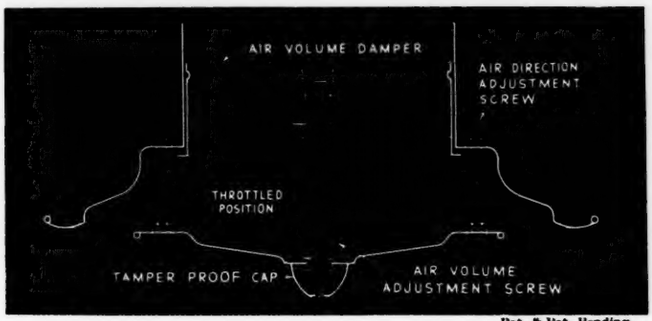

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Volume Damper for fast system balancing regulates the air outlet aperture uniformly without affecting the outlet velocity or diffusion pattern.

Air Direction Adjustment affords any angle of air discharge from vertical to horizontal to accommodate ceiling height, individual, seasonal, or air pattern requirements.

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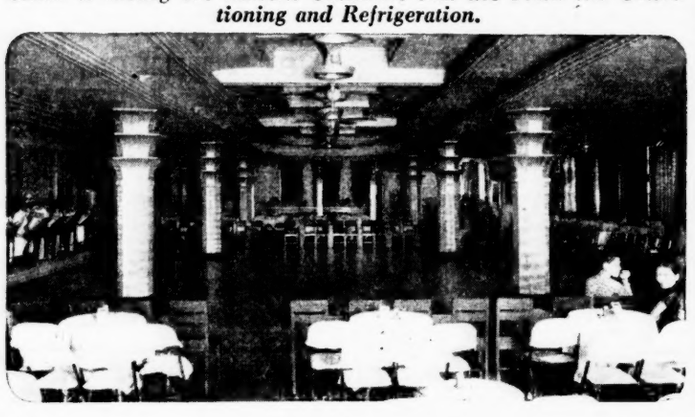

NEW CATALOGS

Horizontal-Compression Feed Stokers

Specification Sheet No. 608 describes the Whiting horizontal-compression feed stoker which operates so as to feed coal to the fire across the front end of the grate by reciprocating action of grate sections. These stokers are said to burn any grade of bituminous coal. —*Whiting Stoker Sales Co. 11 So. LaSalle St., Chicago 3, Ill.* 84

Motors

Slip ring induction polyphase motors, 1 to 350 hp, for use where conditions require a reversible, varying speed, high starting torque, low starting current motor, are described in an 8-page bulletin, Form 643.—*Century Electric Co., St. Louis 3, Mo.* 85

Lightweight Welded Pipe

Applications of light weight Naylor lock-seam spiralweld pipe are illustrated in a 56-page book, Catalog 44. Illustrations show how light weight pipe is used to advantage for ventilating service. This 4 to 30-in. pipe has been used for ventilating tunnels, ventilation lines for power plants and paper mills, and for exhaust and intake piping on construction jobs.—*Naylor Pipe Co., 1230 E. 92nd St., Chicago 19, Ill.* 86

Induction Motor

Bulletin No. 720 covers Allis Type OG (protected type) standard squirrel cage induction motor. Copy of the Bulletin covering fully the construction, features, and some typical applications of this motor will be sent upon request.—*The Louis Allis Co., Milwaukee 7, Wis.* 87

Spiral Tube Bulletin

Citing laboratory test data, a new booklet describes and illustrates uses for a spirally formed, lightweight metal tubing. A four-ply "backbone" construction makes the subject tubing sufficiently rigid for use as stacks, stack-lines, and flues. Other uses suggested in the bulletin include blower tubes for ensilage cutters, mine ventilating systems, pulverized-coal circulating lines. Tables and test-illustrations compare the product for weight and strength with other types of material commonly used for many of the same purposes.—*Pratt Industries, Inc., Frankfort, N. Y.* 88

Expansion Joints

Several types of expansion joints for a wide range of operating conditions are described in a 12-page illustrated bulletin. One style, the anchor joint, is described on page 97, this issue.—*Magnilastic Division of Cook Electric Co., Chicago 14, Ill.* 89

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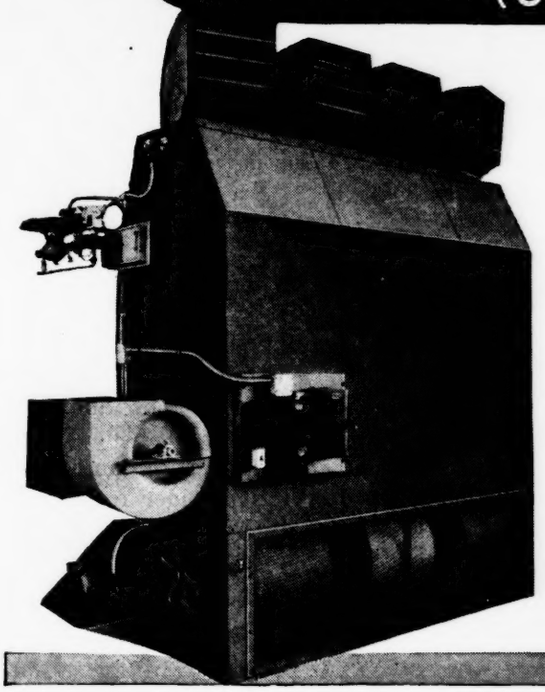

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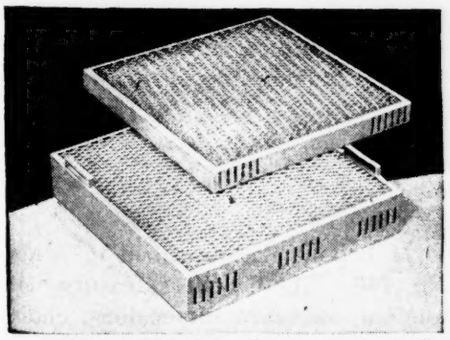

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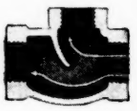
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Two-Stage Centrifugal Pumps

A 2-color, 16-page catalog, Form 7062, entitled "Two-Stage Centrifugal Pumps." Designated Class GT, the pumps described are offered for general use on dewatering service and as station pumps in mines, condensate service in power plants, as hydraulic pumps on elevator service. In addition, the GT is widely used on feed-water service for boiler pressures from 100 to 300 lb. The catalog is illustrated with cutaway views, types of drive, and typical installations; there are tables of performance, dimensions and pipe friction, and a typical pumping problem is worked out in detail. —*Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.* **90**

Low Pressure Oil Burners

An accordion-folded mailing piece outlining the patented features of the Oil-O-Matic Low-Pressure principle of operation with photographs and brief description of all low pressure burners, boiler-burner units and furnace-burner units in the Williams Oil-O-Matic line. A complete descriptive folder for a quick picture of the Oil-O-Matic Low-Pressure line.— *Williams Oil-O-Matic Division, Eureka Williams Corp., Bloomington, Ill.* **91**

Deaerators

Engineering and equipment selection data on atomizing deaerators and other boiler feed water, steam, and condensate conditioning equipment are contained in Publication 4160. This 20-page booklet has sections devoted to hot process water softeners, equipment applications and accessories.—*Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia 32, Pa.* **92**

Pumps

A new bulletin, D-246, covers the Economy line of SCV pumps. The SCV unit is a medium priced, compact, efficient and quiet operating pump. Precision built, it insures trouble-free operation and is extremely durable. Motors are registered in motor stands, high above floor or mounting base, away from dust, dirt and splash.—*Economy Pumps, Inc., Hamilton, Ohio.* **93**

Boilers

Springfield type M boilers are described in a new 4-page bulletin, No. 746. These boilers feature self-supporting construction, standard dimensions, choice of 12 capacities from 160 to 300 lb per sq in., oil or gas firing, and simplified erection.—*Springfield Boiler Co., 1945 E. Capitol Ave., Springfield, Ill.* **94**

Stokers

Bulletin No. 602 describes Whiting stokers for commercial and industrial applications. Capacities from 200 to 2000 lb are pictured with operating and maintenance data.—*Whiting Stoker Co., 11 S. LaSalle St., Chicago, Ill.* **95**

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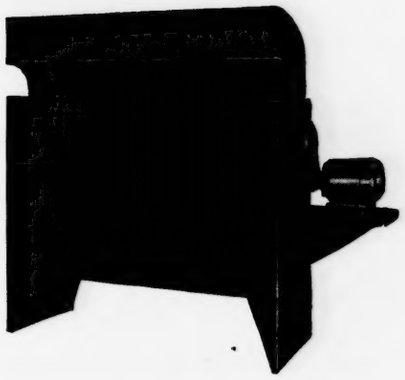

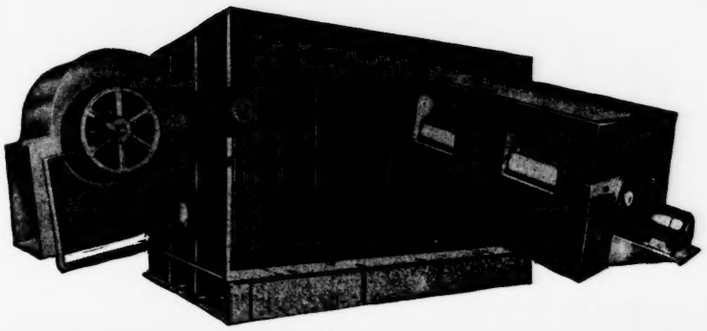

Massachusetts Blower Type Unit Heaters, floor and ceiling type, are available in 13 standard sizes, with REGULAR or NON-FREEZE coils. Catalog Bulletin No. 98.

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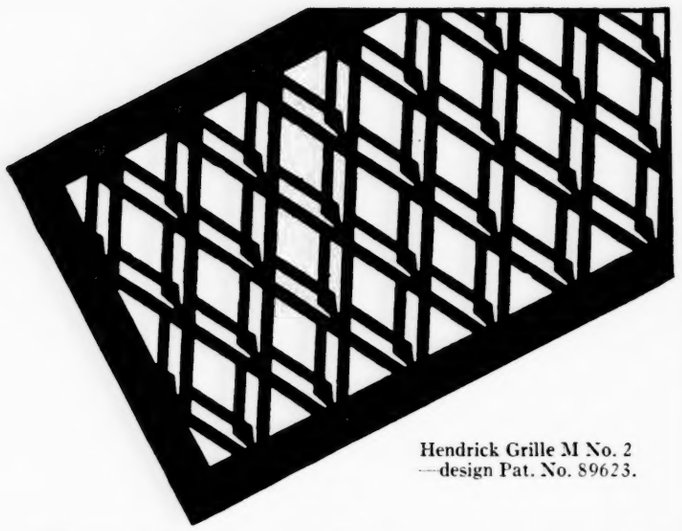

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Bulletin No. 16 gives comprehensive coverage on low temperature refrigeration applications. The information contained will be generally useful to the application engineer in the freezing temperature field. The rapid selection tables are a great time saver in the selection of low side and high side equipment for freezer jobs most commonly encountered.—*Kramer Trenton Co., Trenton 5, N. J.* **96**

Testing Machines

A new series of illustrated data folders covers Bowser laboratory and production testing machines which provide controlled temperature environment and simulate altitude conditions including sub-zero cold, relative humidity and vacuum conditions.—*Bowser, Inc., Refrigeration Division, Terryville, Conn.* **97**

Cold Storage Insulation

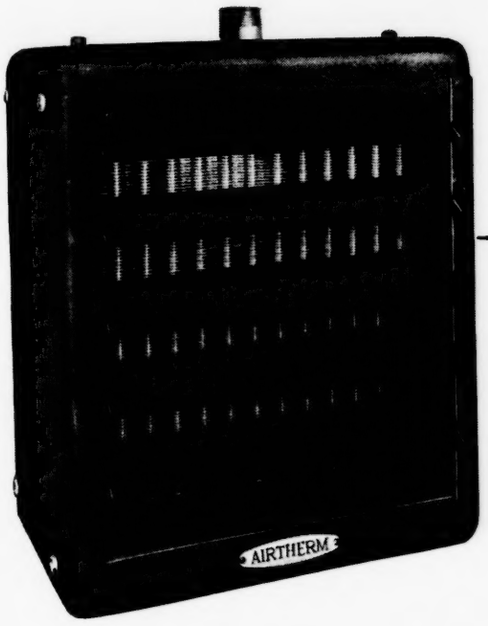
A new, 28-page, illustrated, instruction manual dealing entirely with insulation in the low temperature and cold storage fields, contains detailed data and application instructions pertaining to cold storage insulation supplemented by charts and drawings. The book is made up of three sections, the first devoted to the characteristics of Eagle-Picher low temperature insulations. The second section emphasizes the importance of the vapor barrier. The booklet also includes a chart showing the actual temperatures and humidities most desirable for the storage of various foods as well as other products, both for short-time and long-time storage.—*The Eagle-Picher Co., Dept. CSM, American Bldg., Cincinnati 1, Ohio.* **98**

Flow Rate Meter

A small size low cost Rotameter developed specifically for purge line (bubbler) service is described in catalog-section 31-E. A die cast unit so small it fits into the palm of the hand, this meter gives accurate, precise flow rate measurement with minimum space requirement and can easily be mounted in multiple on a panel. It may be furnished with or without an integral needle valve.—*Fischer & Porter Co., Dept. 1T, Hatboro, Pa.* **99**

Regulator Sound Slide Film

A new 35 mm. sound-slide film showing methods of handling pressure and temperature control problems, has been announced by Leslie Co., manufacturers of pressure and temperature regulators, controllers, strainers and whistles. The film (running time about twenty minutes) follows the steam system of a typical industrial plant from the high-pressure steam at the boiler through the power generating equipment, processing machinery, boiler auxiliaries, heating and low pressure steam systems. The complete film story is re-told and illustrated in a handy 24-page booklet which is given each person at the conclusion of the show. Arrangements for showing this slide-film can be made direct through Leslie Co., or through any Leslie agent.—*Leslie Co., Delafield Ave., Lyndhurst, N. J.* **100**



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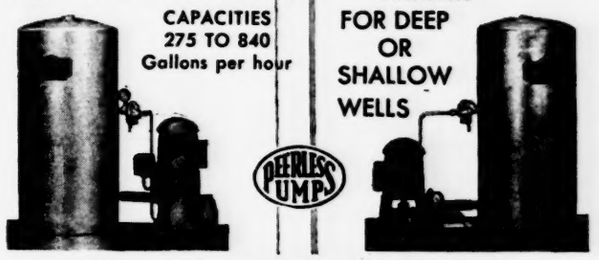

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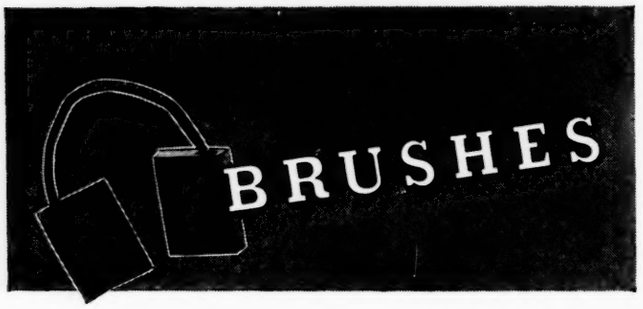

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Heaters

A complete line of Spencer heaters including steel boilers for all types of fuel and all types of building is described in Spencer's 50th Anniversary Catalog.—*Spencer Heater Division, Aviation Mfg. Corp., Williamsport, Pa.* 101

Process Controllers

"Instruments and Controls for Process Industries," a new bulletin, No. 17, describes process controllers, control components, measuring components and instrument combinations. Application data such as sizes, pressure standards and ranges are listed for the various components. Typical control systems of both the single and multiple element type are illustrated.—*Bailey Meter Co., Cleveland 10, Ohio.* 102

Filters

A new Drico booklet, "Filters," is a treatise on the underlying principles of efficient filtration of gases and liquids and its necessity, with an explanation on Vokes principles and their applications in air conditioning and other fields.—*Drico Industrial Corp., 29 Broadway, New York 6, N. Y.* 103

Water Level Control

"Controlling Water Level on Combustion Engineering Type VU Boiler" is the title and subject of Bulletin 455.—*Northern Equipment Co., Erie, Pa.* 104

Cold Diffusers

A 14-page booklet, No. 30-F-2, describes Carrier cold diffusers, designed to provide unitary equipment to meet the varied requirements of product cooling, freezing, and storage. The booklet illustrates both suspended and floor-type models with construction details and tables of physical and performance data.—*Carrier Corp., Syracuse, N. Y.* 105

SEPTEMBER, 1946

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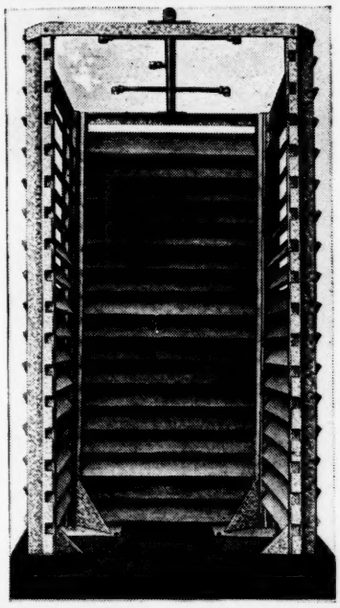

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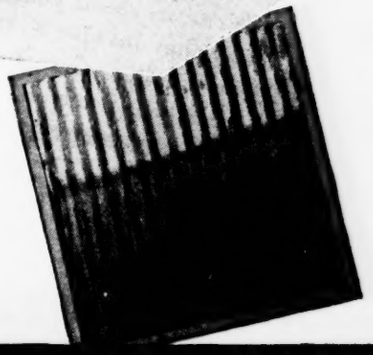

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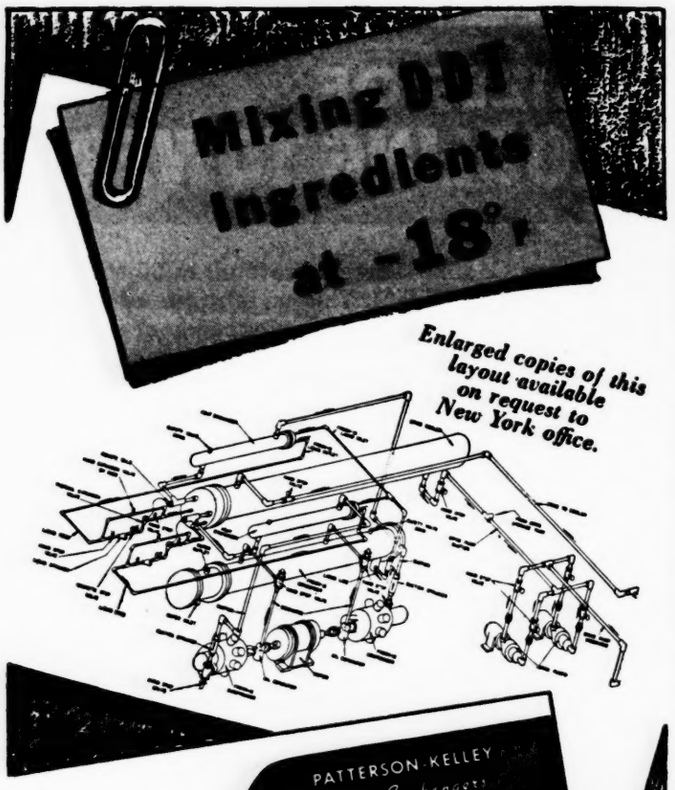

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Heat Exchangers
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Process Equipment

This cooling system, using Freon 12 for chilling calcium chloride brine which in turn chills the contents of the kettles, is indicative of the way Patterson-Kelley engineers can help process plants make effective use of heat-transfer equipment. With 3 Jacketed Kettles, a Cooler, a Condenser, and 2 Heat Exchangers of our design and manufacture, it comes close to being an all-Patterson-Kelley installation.

In planning this installation two basic problems were encountered: (1) the design of jacketed kettles to be operated at sub-zero temperatures; and (2) the design of the cooling system which would most effectively and economically provide the required low temperature.

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Getting Personal

L. N. Roberson

L. N. Roberson *(Radiant Heating by Electricity*, page 89) heads the L. N. Roberson Co., which primarily is engaged in the manufacture and erection of steel greenhouses and heating and ventilating equipment for agricultural use.

During the war Mr. Roberson worked in the Hull Engineering Division of Todd Pacific Shipyard —later as electrical engineer, 13th Naval District Headquarters, Public Works Division. When the war ended he was design engineer in charge of the Public Works Design Section, U. S. Naval Station, Seattle, Wash.

He owns and operates a commercial nursery where his equipment is tested. Mr. Roberson is a past president of the Washington State Nurserymen's Association.

Robert H. Emerick *(Buying Used Mechanical Equipment*, page 62) is a survivor of the Japanese bombing of Pearl Harbor.

Born in Harrisburg, Pa., he was for many years in public utility engineering—for 15 years with the Philadelphia Electric Co., and later with Electric Bond and Share in New York City. He joined the Navy in March, 1941, and after a short tour as mechanical engineer for the 14th Naval District with headquarters at Pearl Harbor, he was placed on active duty as an assistant machinery planning officer. While there, the Japs made their historic call.

For the next three years he continued at Pearl Harbor to help keep the damaged fleet in condition. In July, 1944, Mr. Emerick was transferred to the Charleston, S. C., Navy Yard as repair and conversion officer. He was discharged in April, 1946, with the rank of Captain.

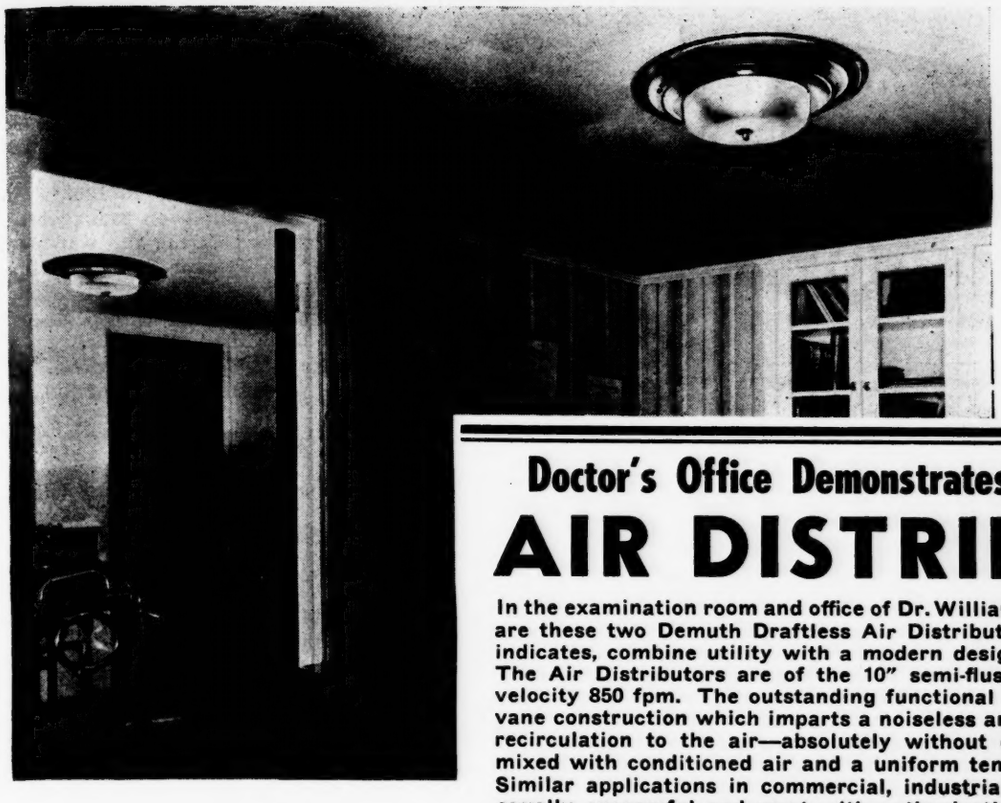
Since then he has completed a book on refrigeration and air conditioning which will be published by Prentice-Hall in January, and he has served as a consulting mechanical engineer in Florida. His Navy background has given him experience in evaluating used mechanical equipment.

. . . Since the Last Issue

Henry Valve Co. announces the appointment of **Edward A. Flesh** as field engineer in the eastern territory. He will have headquarters at 7230 Limekiln Pike, Philadelphia 38, Pa., and will cover Eastern Pennsylvania, New Jersey, Delaware, Maryland and Virginia. Mr. Flesh comes to Henry Valve after many years with Merchant & Evans and Mueller Brass Co.

The first sales conference since 1941 of all field sales personnel of **Airtemp Division of Chrysler Corp.** was held in Dayton, July 15-20, and attended by over 100 representatives from throughout United States and Canada. The program started with a trip through the Airtemp plant where a $10,000,000 expansion project is underway.

Air conditioning and frozen foods, two youthful giants of the mechanical refrigeration industry, will share the spotlight in four exhibition halls of the Cleveland Public Auditorium, October 29, when the industry opens a four-day exposition of its entire range of new products. More than 150 companies already are participating in advance plans, and exhibits are expected to number 300, according to officials of the **Refrigeration Equipment Manufacturers Association** which is sponsoring the show with the cooperation of other organizations.



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In the examination room and office of Dr. William Rexer of Bayridge, New York, are these two Demuth Draftless Air Distributors which, as the above photo indicates, combine utility with a modern design motif and effective lighting. The Air Distributors are of the 10" semi-flush type—ceiling height 6' 8"—velocity 850 fpm. The outstanding functional feature is the patented curved vane construction which imparts a noiseless and positive 360° circulation and recirculation to the air—absolutely without draft. Room air is effectively mixed with conditioned air and a uniform temperature is easily maintained. Similar applications in commercial, industrial and private installations are equally successful and meet with enthusiastic responses. Write to Demuth for information on the modern method of air distribution.

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STOKER ENGINEERING *at its best!*

Your CUSTOMER wants a stoker that provides the greatest amount of comfort and convenience with the best economy. You want to sell a stoker that will deliver these factors for the most years with the least amount of service. Customer satisfaction creates sales—reduced service costs increase profits.

GEHL STOKERS

In Gehl Stokers you get engineering that has met the test over a period of many years . . . stokers built to do a better job for more years, by a 79-year-old company. You get friendly, experienced cooperation based on a long-time knowledge of stoker merchandising.

Among the many features that make Gehl Stokers outstanding are: Heavy, all-cast, rust-resisting chassis . . . Barometric automatic control of chimney draft . . . Unit air and coal feed tube that insures even distribution of air in the fire bed . . . An auto-type transmission . . . A retort that assures efficient combustion. Domestic and industrial models now available.

WRITE today for literature and details of the Gehl dealer program.

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A GEHL WINS FRIENDS WHEREVER IT GOES

YARWAY SPRAY NOZZLES

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FAN-TYPE FOR FLAT SLICING SPRAY

Get the most out of your Spraying Equipment.

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Wide range of sizes and capacities. Thousands in use. Write for new Bulletin N-616.

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CLOSE REGULATION

NOMINAL COST

V-300 Series Regulators control the flow of natural, manufactured and liquefied petroleum gases. Widely used for space, range and water heaters, floor furnaces, central and unit heating systems, hot water and steam boilers, conversion boilers, core and baking ovens, fryers, dryers, and other gas fired applications in homes and industry. Capacity up to 2085 cu. ft. per hour with accurate regulation, yet compact and light in weight. Sizes up to and including 1¼" I.P.S. available. For larger sizes contact factory.

For complete specifications on Gas Regulators, fuel governors, control and safety valves and thermostats for the Gas Industry, write for the new 1946 Catalog 52C.

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The **Spang-Chalfant Division of The National Supply Co.**, made four promotions effective August 15. **Charles J. Ramsburg, Jr.** and **Eugene F. Conroy** as assistant district managers of the New York office; **Edwin A. Booth** as Pittsburgh district manager and **Frank W. Morris** as manager of the Tulsa district. Mr. Ramsburg, a graduate of the Sheffield Scientific School of Yale University in 1932 with a degree in Industrial Engineering, had been manager of the Pittsburgh district since 1939 and during the war also was manager of the Ordnance Department Sales. During the past six years Mr. Conroy has been a member of the sales staff of the company's New York office. Mr. Booth, the new Pittsburgh district manager, had been manager of the Tulsa district since 1942. Mr. Morris, new manager of the Tulsa division, entered the sales department of Spang-Chalfant in 1925.

The appointment of **J. C. Hosford** as publicity assistant is announced by Norman J. Radder, secretary of the **Plumbing and Heating Industries Bureau.** Mr. Hosford, who is a graduate of the School of Journalism of the University of Missouri, has had several years experience in newspaper work and public relations, including a year with the United Press in Los Angeles.

Bituminous Coal Research is sponsoring a 3-year study at the University of Illinois to develop data that will lead to maximum satisfaction with bituminous coal for residential heating. The study will be in charge of the Department of Architecture of the university. The three-phase study consists of an investigation of the most effective use of existing coal-burning and coal-handling facilities, practical house design, and the development of new ideas for coal and ash handling equipment and its arrangement. The University of Illinois, which has been a center of cooperative house-heating research, will provide a home clinic of national scope on its campus. The architectural engineer to head this special research is to be appointed.

Joseph L. Rauh, for three and one-half years a staff officer for General Douglas MacArthur, has been appointed general deputy to Wilson W. Wyatt, housing expediter and administrator of the **National Housing Agency.** Mr. Rauh, who retired from the Army with the rank of lieutenant colonel last December, will give up his private law practice in Washington to take the assignment as the No. 2 man in the veterans' emergency housing program. He succeeds Rear Admiral Kirby Smith (CEC) USNR, who resigned recently to return to private business.

The Powers Regulator Co., pioneer manufacturer of automatic temperature control equipment, has announced the opening of new offices for its Chicago sales personnel at 3819 North Ashland Ave. The growth of the sales organization has necessitated its separation from the general offices and factory in its function of sales, service, installation and repair work.

W. B. Connor Engineering Corp. has recently appointed the following in the districts noted to handle their line of Dorex air recovery equipment and Kno-Draft diffusers: **O. K. McCullough Co.,** 1715 Main St., Kansas City 8, Mo.; **Products, Inc.,** 304 Home Federal Bldg., Des Moines 9, Iowa. The following has been appointed to handle Kno-Draft diffusers only: **Russell J. Smith,** 1601 S. Grand Blvd., St. Louis, Mo.

Charles Edgar Hoyt, who during a period of 30 years has served as secretary, convention and exhibits manager, executive vice-president and treasurer of the American Foundrymen's Association, retired on August 1. William W. Maloney, secretary, is now secretary-treasurer. S. C. Massari is technical director.

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NORMAN*
Conversion GAS burners
*FORMERLY NORGAS

New NORMAN*-engineered features appeal to prospects who want the Good Buy in a Gas Conversion Burner. Simplicity and compactness in design spells greater efficiency and longer trouble-free operation for them. The revolutionary NORMAN* improved principle of burning gas means greater fuel economy. Dozens of other NORMAN* features provide plenty of sales ammunition.

Sales multiply easily as satisfied NORMAN* customers sell their neighbors and friends. NORMAN* is fully approved by A.G.A. and local utilities. Fully guaranteed. You can sell — your customers can buy — NORMAN* with complete confidence.

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D. D. Piper, Secy.-Treas.

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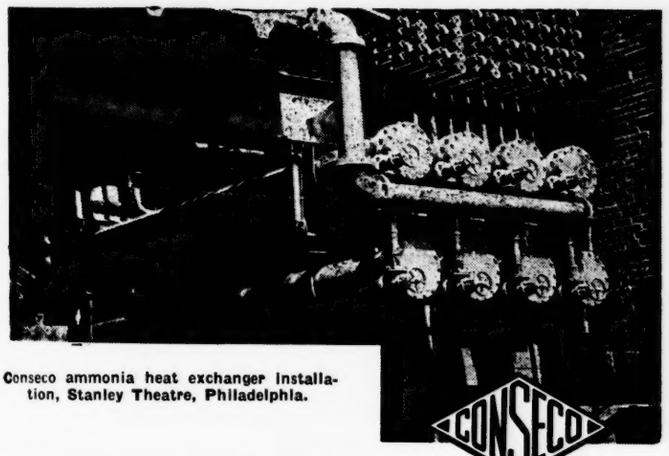

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Twenty years' specialized experience designing, fabricating and servicing heat exchangers assure sound design, quality construction and economical operation with any type refrigerant. Engineering assistance gladly furnished. Write.

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CONDENSER SERVICE & ENGINEERING CO., INC.
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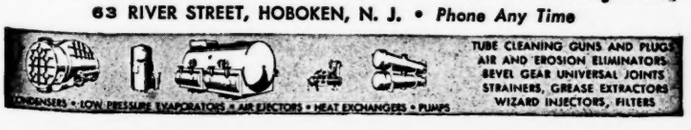
TUBE CLEANING GUNS AND PLUGS
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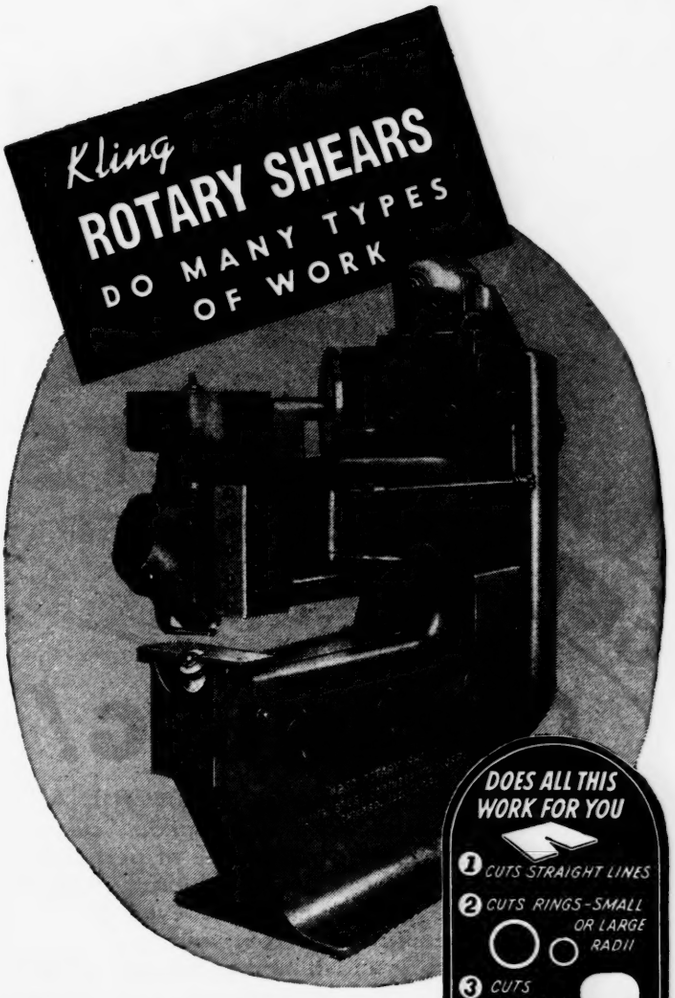
CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS



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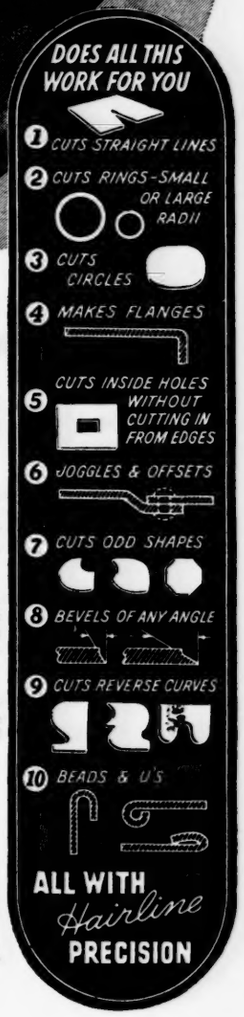
Rapid operation . . . Hairline Accuracy . . . the use of Kling Rotary Shears marks the latest development in cutting mild steel, and sheet metal, up to 1-inch w.th amazing savings in time, labor, and production costs.

For exacting projects (see illustration at the right), no single unit of metal-working equipment does so many different things so cleanly and efficiently as does the Kling Rotary, pictured above.

In metal working plants, automotive, aviation, home appliance, and other industries, where work of this character is being done, — this machine is held in high regard for its versatility and economy of operation.

This great usefulness is the result of half-a-hundred years of engineering experience which prospective buyers, with reason and respect, applaud.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A sales engineer in the Buffalo area for the **Century Electric Co.**, of St. Louis, **William L. Dively**, 45, of 18 East Girard Blvd., Kenmore, died in Louise de Marillao Hospital. He was stricken with a heart attack after coming home from a golf game at the Brookfield Country Club.

Appointment of **H. A. Malcom**, general sales manager, as a vice-president of **Airtemp Division of Chrysler Corp.**, was announced by D. W. Russell, President. Mr. Malcom now will have the joint title of vice-president and general sales manager. Mr. Malcom joined Chrysler Airtemp in 1941 with a background of appliance, automobile and other specialty selling experience, having served as both salesman and sales executive. For two years he was Regional Sales Supervisor in charge of the entire southern half of the United States. In 1943, Mr. Malcom was promoted to the executive post of assistant to the sales vice-president. In this capacity, he coordinated the activities of all factory sales executives in the field. Mr. Malcom was again promoted in 1944, when he was appointed assistant general sales manager of this home heating, air conditioning and commercial and industrial refrigeration division of Chrysler Corporation. In 1945, he rose to the position of general sales manager.

H. A. Malcom

The National Coal Association has announced the appointment of **J. Nelson Stuart** as manager of its newly created coal heating service division. Mr. Stuart is a veteran coal merchandising man and brings to the new post a wide background of experience in public relations, advertising, selling and sales direction covering a period of 23 years.

Nine engineers of the **Westinghouse Electric Corp.**, including five from the staff of the Westinghouse Research Laboratories, will go to Oak Ridge, Tenn., to join the pool of scientific manpower which will work on peacetime applications of atomic power. The engineers will carry on research at an Institute of Nuclear Studies which is being established as a "super-university of the atomic age" to provide channels for cooperative research between government, universities and the industrial concerns which have been involved in the atomic energy project at Oak Ridge. Sponsored by a group of southeastern universities, the Institute of Nuclear Studies will carry out research at the Ph.D. level and above in the fields of physics, chemistry, biology, medicine, and engineering.

The Pure Oil Co. has been franchised by **York-Shipley, Inc., York, Pa.**, to distribute its domestic line of conversion oil burners, boiler-burner units and winter air-conditioners in Minnesota, Iowa, North and South Dakotas and Western Wisconsin.

The appointment of **Dr. C. Richard Walmer** as medical director of **Industrial Hygiene Foundation** at Mellon Institute is announced by Dr. E. R. Weidlein, institute director. Dr. Walmer will hold the rank of Senior Fellow in Mellon Institute. As a full-time physician for Industrial Hygiene Foundation, Dr. Walmer will direct the medical phases of the foundation's work for the improvement of working conditions and the advancement of employee health in industry. He will also serve as secretary of the foundation's medical committee which is headed by Dr. A. J. Lanca, associate medical director, Metropolitan Life Insurance Co., New York.

G. J. Dekker has been elected a vice-president of the Ohio Chemical & Mfg. Co. Mr. Dekker has been affiliated with **Air Reduction Sales Co.**, of which The Ohio Chemical & Mfg. Co. is a subsidiary, since 1919. He was appointed assistant manager of the Detroit district in 1931. After serving briefly as manager of the Oklahoma district, in 1940, Mr. Dekker was returned to Detroit as manager. He held this position at the time of his election.

Stephen H. Newburn has been appointed manager of Air Reduction's Detroit district. A Penn State graduate, Mr. Newburn joined Air Reduction in 1936 as a district representative in Pittsburgh. In 1944 he was made assistant sales manager at Cleveland and was promoted to manager in 1945. Mr. Newburn succeeded G. J. Dekker recently elected vice-president of The Ohio Chemical & Mfg. Co., an Air Reduction subsidiary.

A. C. Brown, Jr., has been appointed manager of Air Reduction's Cleveland district. Mr. Brown started with Air Reduction in 1935. Before entering service, he served as salesman and later as branch manager at Grand Rapids, Michigan. He succeeds Stephen H. Newburn appointed Detroit district manager.

Market studies of important industries to determine the potential requirements for refrigeration and air conditioning equipment will be undertaken by the **Air Conditioning and Refrigerating Machinery Association,** representing many of the larger manufacturers of air conditioning and refrigerating equipment. The first phase of this work, which is already under way, deals with the dairy industry and its sales potential for refrigeration equipment. The work will be carried on to supplement market research activities of member companies and to provide a source for public information about the increasing use of refrigeration and air conditioning equipment for production purposes by other industries.

A. M. Byers Co., manufacturers of wrought iron, has announced the appointment of **George B. Coffey** as manager of the firm's Chicago division, with offices in the Conway Building. Mr. Coffey succeeds W. A. Taylor who has resigned to enter private business. A native of Freedom, Indiana, Mr. Coffey was graduated from the University of Indiana in 1924. He has been with A. M. Byers Co. since 1930. Mr. Coffey is president of the Bridge & Building Men's Association and a member of the ASHVE.

G. B. Coffey

Corrosion of metals, cause of one of the world's greatest economic losses, will be studied in a coordinated program of instruction and research at the **Massachusetts Institute of Technology,** it was announced recently with the appointment of **Dr. Herbert H. Uhlig** as an associate professor in the department of metallurgy to take active charge of the project. Dr. Uhlig graduated from Brown University in 1929 and completed his work for the doctorate at M.I.T. in 1932. After a year as physical chemist at the Rockefeller Institute he went to Lever Brothers as research chemist and became assistant chief chemist in 1937. He then joined the M.I.T. research staff to take charge of a project dealing with the corrosion of stainless steel. Later he was called to the Research Laboratory of the General Electric Co. where he has been engaged in research on corrosion and allied problems. Dr. Uhlig has published a number of papers on corrosion and is editor-in-chief of "The Corrosion Handbook" to be published shortly.

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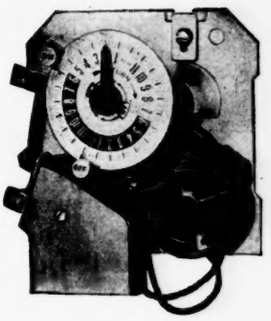
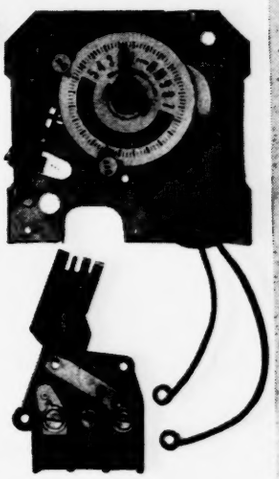
TIME SWITCH is Well Engineered

DESIGN FEATURE No. 4

Rugged, Easily Replaced Terminal Block





The terminal block is molded from Bakelite. Ample provision is made for heavy wire connections. Over-size Terminal screws permit firm pressure to insure good electrical contact.

The terminal block is removed by turning out two screws. The block also carries the contact blades which can be easily adjusted or replaced.

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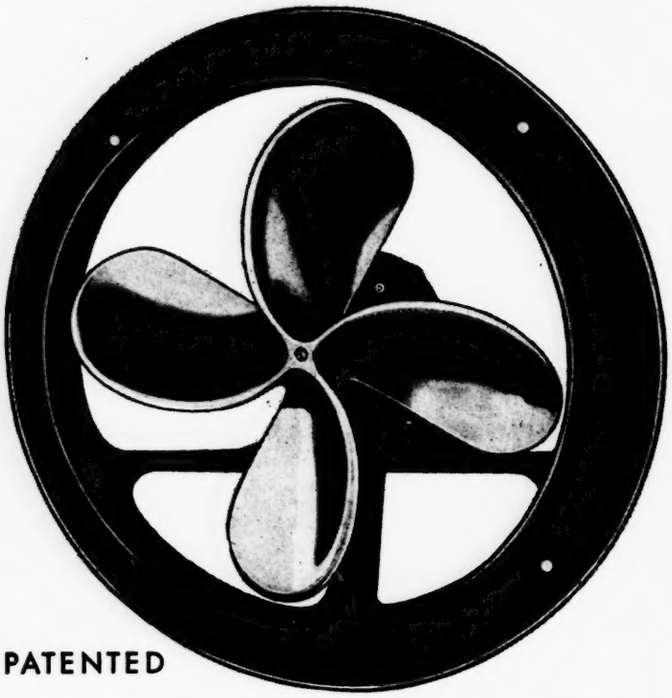

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Design of Stilphen "Stil-Blade" Exhaust Fans makes them ideal for tough exhausting jobs where top notch equipment is required. They're built to move large volumes of air in a straight line quietly, uniformly and with high efficiency.

Fan wheels operate without dead centers, eddy currents and air friction. A smooth, uniform flow of air over the entire surface of the fan blade assures silent, economical operation and the most positive performance attainable.

All fan blades are of aluminum-copper alloy, cast in one piece to eliminate the chance of the blades working loose to throw the fan out of balance or cause accidents. Fan and motor are mounted in cast iron support ring, cast in one piece for long, dependable service life. All types and sizes of these fans are available for horizontal or vertical operation.

Act now! Incorporate Stilphen "Stil-Blade" Fans in your products for better performance and more economical operation. There's a size and type fan to fit every type exhausting installation.

In addition to Stilphen "Stil-Blade" Exhaust Fans, Howry-Berg manufactures Hot Water Pumps and Evaporative Air Conditioning Units.

Write for product bulletin. Howry-Berg Steel & Iron Works, 2949 N. Speer Blvd., Denver 11, Colorado.

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COMING EVENTS

SEPTEMBER 10-14, 1946—Fourth National Chemical Exposition, Coliseum, Chicago, in conjunction with Semi-Annual Meeting of the American Chemical Society, at the Palmer House, Stevens Hotel, and other hotels located near the Coliseum. Dr. H. E. Robinson, chairman of show committee, Coliseum, Chicago 5, Ill.

SEPTEMBER 16-20, 1946—1946 Exhibit and Conference of the Instrument Society of America, to be held in Pittsburgh, Pa. Paul G. Exline of the Society at 1117 Wolfendale Street, Pittsburgh 12, Pennsylvania.

SEPTEMBER 19, 1946—Annual Meeting, Plumbing and Heating Industries Bureau, at Palmer House, Chicago. Norman J. Radder, Secretary, 35 East Wacker Dr., Chicago 1.

SEPT. 30-OCT. 2, 1946—Fall Meeting, American Society of Mechanical Engineers, Boston, Mass. Secretary C. E. Davies, 29 W. 39th St., New York, N. Y.

OCTOBER 7-11, 1946—28th Annual Convention and Exhibition, American Gas Association, Atlantic City, N. J. Exhibits in Auditorium; meetings in several hotels. American Gas Association, 420 Lexington Ave., New York 17, N. Y.

OCTOBER 24-25, 1946—Joint Fuels Conference of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, at the Bellevue-Stratford Hotel, Philadelphia, Pa. A. W. Grosvenor, Drexel Institute of Technology, Philadelphia, Pa.

OCT. 28-NOV. 1, 1946—REMA Annual All-Industry Refrigeration and Air Conditioning Show, Cleveland Public Auditorium, Cleveland, Ohio. Refrigeration Equipment Manufacturers Association, 43 East Ohio Street, Chicago 11, Ill.

WEEK OF NOVEMBER 11, 1946—74th Annual Meeting of the American Public Health Association, to be held in Cleveland, Ohio. Further details from Dr. Harold J. Knapp, Health Commissioner, Cleveland, Ohio.

NOVEMBER 17-22, 1946—Annual Meeting, American Welding Society, Hotel Ambassador, Atlantic City, N. J. Office of Secretary, 33 W. 39th St., New York 18, N. Y.

DECEMBER 2-7, 1946—17th National Power Show, Grand Central Palace, New York. Charles F. Roth, manager, International Exposition Co., Grand Central Palace, New York 17, N. Y.

JANUARY 27-31, 1947—7th International Heating and Ventilating Exposition, Lakeside Hall, Cleveland, Ohio. Sponsored by The American Society of Heating and Ventilating Engineers in conjunction with their 53rd Annual Meeting. Charles F. Roth, manager, International Exposition Co., Grand Central Palace, New York 17, N. Y.

REE
BRARY

HEATING AND VENTILATING

AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION

Five Miles of London Subway Converted to Air Conditioned Factory . . . page 74

Does Night Shutoff of Heating Pay? . . . . . page 65

Unit Ventilators for Schoolrooms . . . page 69

Do Swing Joints Swing or Bend? . . . . page 72

Design and Performance of Axial Flow Fans . . . . . page 83